AGRICULTURAL PRODUCTIVITY AS A COMPONENT IN THE REGIONAL DEVELOPMENT OF THE SUB-HIMALAYAN EAST [DEORIA, GORAKHPUR, BASTI AND GONDA DISTRICTS]

ABSTRACT

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ABSTRACT

The present study deals with the regional patterns of agricultural productivity, levels of development and their interrelationships as obtained in the Sub-Himalayan East region of Uttar Pradesh. Agricultural productivity is viewed as the measure of the efficiency with which the agricultural system in the region works. The Sub-Himalayan East region is predominently an agricultural region as eighty-five per cent of total workers in the study area are engaged in agricultural activities. As such, agricultural productivity of the region has been taken as the major component of the regional development.

The Sub-Himalayan East region is hemmed inbetween the Ghaghara river on the south and the Nepal <u>tarai</u> on the north. Its western boundary is formed by Bahraich district and the eastern boundary being separated by Bihar state. The study area includes Deoria, Gorakhpur, Basti and Gonda districts of Uttar Pradesh. It extends from $26^{o}5'$N to $27^{o}55'$N latitudes and $81^{o}34'$E to $84^{o}26'$E longitudes covering an area of 26,356 km^2.

There are minor differences in natural characteristics of structure and relief, drainage, climate and soils. The

region is a part of Ganga Plain which is built up of recent alluvium brought by the sediments eroded by the Himalayan rivers in the north and the Peninsular rivers in the south. The thickness of the alluvium varies from 400 metres to 6000 metres. The sediments of the alluvium consist of sand, silt and clay with occasional gravel beds and lense of peaty organic matter. The alluvium deposits of the area have been classified into two broad divisions: (i) Bhangar (older alluvium) and (ii) Khadar (newer alluvium).

The bhangar land occupies the higher land and is not inundated by rivers during rains, whereas the khadar land generally stretches along the river and is occasionally flooded during the rains. A third group of alluvium locally known as bhat is confined to the eastern part of the area. It contains a high amount of calcareous matter and lime, and thus attains a unique characteristic. The whole plain is a flat region generally sloping from northwest to southeast. The only variation in the monotonous topography is due to rivers. All the rivers flow in a southeasterly direction. There are two major river systems: Ghaghara in the south and the Rapti in the north.

Sub-Himalayan East region experiences a sub-tropical monsoon type of climate which is characterized by a seasonal rhythm produced by the southwest and northeast monsoon winds. The variations in the seasonal rhythm largely control the agricultural operations in the area.

The soils of the area which are made of the alluvium brought by the Rapti, Ghaghara and Gandak rivers, have been very much affected by the local climatic and vegetative conditions and topography. The alluvium of the area has been classified into sandy, kachhar, loamy, clayey loam, clayey and bhat soils.

The present study of agricultural productivity and regional development is based on available statistical informations from the records and bulletins and personal observations of the four Districts of the area under study. An appropriate micro level unit i.e. development block[1] is taken as the unit of analysis.

In the foremost section of the study conceptual and methodological framework of agricultural productivity

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1 Block is a small administrative unit consisting generally of 150 villages, covering approximately an area of 200 sq. km.

and regional development have been discussed in detail. Agricultural productivity may be defined as the measure of the efficiency of the agricultural system. There are various methods and techniques to measure the agricultural productivity. Most of them are partial measures of agricultural productivity. In the present study five indices of agricultural productivity have been included for the evaluation of agricultural productivity. These indices are Standard Nutrition Unit per hectare, agricultural output per hectare, agricultural output per agricultural worker, Bhatia's productivity index and Shafi's productivity coefficient index. These indices individually as well as collectively make a declining pattern in agricultural productivity from east to west in the area under study. These indices also have positive correlations with each other. The highest correlation among all the five indices exists between SNU per hectare and Shafi's productivity coefficient index. The distributional pattern of aggregate productivity shows that very high and high regions of productivity cover the entire district of Deoria and a large part of Gorakhpur district. This region generally specializes in the production of sugarcane which is a major cash crop in the area under study. Besides high income from sugarcane this is the region where the effect of

Green Revolution is strongly felt. The areas of moderate agricultural productivity are found in southern Basti district and western Gorakhpur district. This region is characterized with the foodgrains production especially rice, wheat and pulses. In this region development of agricultural technology is of moderate order. Most of the northern Basti and Gonda have extensive regions of low and very low productivity level. This region is also characterized with the foodgrains production. However, yields of crops per hectare is low in comparison to the region of medium productivity level.. It is mainly due to low fertility of soil in the region and lack of irrigation facilities. These drawbacks are added with the low level of technological development in the area.

In the regional analysis of development there are regions which are well developed and the people in such regions enjoy reasonable standard of living while in others resource utilization.and development is low for historical circumstances or otherwise resulting in the underdevelopment of the region whereby people have a poor standard of living. Regional development, therefore, is interpreted as intra-regional development designed to solve the problems of regions lagging behind. The first connotation of regional development is economic in which the differences in growth, in volume and structure of production, income, employment are taken as the measure of economic progress. However, recently it has been argued that merely economic criteria cannot explain the level of development which is a multidimensional concept. Therefore such variables or criteria should also be employed which indicate progress on technological, social and cultural fronts. Thus development means progress throughout the society. However, at the base of the development process there should be progress in different sectors of the economy. In the present study twenty variables have been selected to delineate the regions at varying levels of development using factor analysis technique. These variables of 117 blocks of the area yield five major factors which together account for 75 per cent of the total variance in the regional development of the area. Examination of the rotated factor loadings on these factors rendered them to be labelled as dimensions of agricultural mechanization and infrastructure, institutional development and agricultural intensity, industrialization and education, urbanization and modernization and infrastructural underdevelopment. The first two factors are mostly related to the agricultural development which include more than 33 per cent of the total variance explained. This mainly highlights the agricultural specialization of the area. Industrialization and education rank third in order while urbanization and modernization rank fourth. Infrastructural underdevelopment is less significant as it takes fifth position and lies in the negative side of the development scale.

To find out the composite index of development all the five factors are aggregated. They altogether show the overall level of development. In the regional patterns of the level of development the blocks of very high and high levels of development are mainly concentrated in the eastern part of the area. These blocks score very high and high on the dimension of agricultural mechanization and infrastructure. However, they are centred on one or other urban centres. Therefore, the majority of these blocks show very high and high factor scores on the dimension of urbanization and modernization. The blocks having medium level of development are distributed throughout the area with a major concentration in the eastern half and southcentral part. This level of development on cartographic comparison is found to be strongly related to the dimension of agricultural mechanization. The level of low and very low development is mainly concentrated in the western half with very few scattered pockets of low development in the eastern half of the area. When compared with the dimensions of development in the area, it is found that low and very low level of development is highly associated with institutional development and agricultural intensity i.e. low level of this dimension of development contributes significantly to the low level of development of this region. The low development of this region is also due to low level of industrial and educational development on the one hand and agricultural mechanization and infrastructure on the other. The relationship between agricultural productivity and levels of development has been depicted in a scatter diagram which show a positive correlation.

The findings of this analysis verify the hypothesis that agricultural productivity is a major component of regional development, i.e. higher levels of development are associated with the higher levels of agricultural productivity and vice versa. In the area under study agricultural productivity appears to be a factor of urbanization, industrialization, infrastructural development and social development. In the conclusion an attempt has been made to measure additional output in terms of standard nutrition unit (SNU) per hectare or persons that can be afforded per hectare in the less developed productivity regions. To this effect the Cobb-Douglas production function is fitted to the productivity (SNU/hectare) as dependent variable and irrigation, fertilizers, high yielding varieties of seeds, tractorization and agricultural workers as independent variables (inputs determining the productivity level). A significant relationship is obtained. According to this analysis an additional population of 22 persons per hectare in the very low productivity regions and 28 and 36 persons per hectare in the low and medium productivity regions, respectively can be afforded by bringing one per cent change in the input variables.

This analysis is further extended to calculate the available and the surplus SNUs by 2001 A.D. in different regions. It is found out that only one per cent increase in inputs in the very low productivity region will be sufficient to support the total population of the study area and the output of low and medium productivity regions will be in surplus by the turn of the century.

The analysis reveals that low levels of agricultural productivity and resulting backwardness of the regions of low and medium productivity in the area is mainly due to lack of commercialization in the agricultural sector. To develop these areas it is necessary to induce commercialization and monetization in the agricultural sector of those regions. To achieve this goal certain suggestions are made in the conclusion.

The present study despite limitations has succeeded in demonstrating regional variations at micro level in agricultural productivity and levels of development. It has succeeded in delineating areas of problems and progress with respect to agriculture and general development. It has also succeeded in confirming the hypothesis of interrelationship between agricultural productivity and regional development. However, it is felt that this hypothesis should be tested in respect of other regions so that uncovered links between agricultural productivity and development could be exposed.

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CERTIFICATE

This is to certify that the work embodied in this thesis entitled, 'Agricultural Productivity as a Component in the Regional Development of the Sub-Himalayan East (Deoria, Gorakhpur, Basti and Gonda Districts)' is an original work of Mr. Abdul Munir completed under my supervision. The thesis is suitable for submission for the award of the degree of Doctor of Philosophy in Geography.

(Prof. Mohammad Shafi)
Supervisor

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Aligarh
1987

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INTRODUCTION

PROBLEM AND HYPOTHESES

This is a study of the regional patterns of agricultural productivity, levels of regional development and their interrelationships as they obtain in the Sub-Himalayan East of Uttar Pradesh. The study examines regional patterns of agricultural productivity in detail in the area under study and analyses their socio-economic and environmental correlates which are likely causes of spatial variations in the agricultural productivity. Agricultural productivity is viewed as a measure of efficiency with which the agricultural system in the region works. As such, variations in the agricultural productivity reflect disparities in the use of agricultural resources in the area at the level of development blocks. Since agriculture is the mainstay of the economy of the region, where about 85 per cent of the population is engaged in agricultural activities, differences in the agricultural productivity may be taken as the differences in the economic progress of the region. In other words, if it is presumed that economic and social development go hand in hand, the agricultural productivity in the region can be taken as the major component of the regional development.

In the regional analysis of development one comes across regions which are well developed and the people in such regions enjoy reasonable standard of living while in others, resource utilization and development is low owing to historical circumstances or otherwise, resulting in the underdevelopment of the region whereby people have a poor standard of living. The problem of imbalance in regional development thus assumes a great significance. Regional development, therefore, is interpreted as intra-regional development designed to solve the problems of regions lagging behind. The first connotation of regional development is economic in which the differences in growth, in volume and structure of production, income, employment are taken as the measure of economic progress. However, recently it has been argued that merely economic criteria cannot explain the level of development which is a multidimensional concept. Therefore, such variables or criteria should also be employed which indicate progress on technological, social and cultural fronts. Thus development means progress throughout the society. However, at the base of the development process lies progress in different sectors of the economy.

Regional development in an overwhelmingly agricultural situation can only be achieved by developing agriculture and reducing gaps between regions with regard to the efficiency of the agricultural system. Progress in agriculture releases resources - labour as well as capital - for use in industry and services. Progress in agriculture also leads to the modernization and social development and better level of living through education and generating propensity to consume other than agricultural goods.

Progress in agricultural productivity and levels of development may thus be hypothesized to be interrelated. Testing of this hypothesis in the area under study is the crux of the research problem. Findings of this research may help to design plans and formulate policies for the development of the area in general and reducing regional disparities at micro level in particular.

The objective of the study as stated earlier is to delineate areas of high and low agricultural productivity, to delineate regions at varying levels of development and to examine the relationship between the agricultural productivity and the levels of development.

RESEARCH DESIGN

The analysis of agricultural productivity, levels of development and their interrelationships involve measurement of agricultural productivity and levels of development.

The measurement of the agricultural productivity and levels of development involve multiple variables, and falls in the domain of multivariate analysis. Operationalization of analyses of multidimensional concept of development implies application of statistical models to the empirical situation. The problem at hand, which involves analysis of a large number of relationships essentially lies in the realm of multivariate statistical analysis. However, application of these models and techniques involves certain issues. These are connected with the availability of data, unit of analysis, selection of variables and techniques of analysis. Following sections consider the theoretical and the practical aspects of these issues.

(i) Data Base

Agricultural productivity is calculated by using data on area and production of different crops, population and workers. The data for the calculation of productivity indices are obtained from District Statistical Bulletins. These bulletins pertain to the years from 1978-79 to 1982-83 which are available from the District Statistical Offices. Data on population and workers by development blocks are also obtained from District Statistical Offices. These data pertain to the year 1981. In order to analyse and measure levels of development a large number of variables relating to agricultural development, urbanization and industrialization, infrastructure and amenities and social development are also taken from District Statistical Offices and Bulletins. Most of the data on the aspects of development pertain to the year 1981. A small number of variables of development are averages over five years from 1978-79 to 1982-83.

(ii) Unit of Analysis

The problems of unit of analysis is that of scale in geography. The issue involves selection of an appropriate unit of analysis. Robinson in the context of 'ecological fallacy' has pointed out that, the extent and sometimes even the direction of relationships among variables may change with varying size of unit of analysis.[1]

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1 Robinson, W.S., Ecological Correlation and the Behaviour of Individual, American Sociological Review, Vol.15, 1950, pp.351-57.

Similar observation is made by McCarty, Hook and Knos, 'every change in scale will bring about the statement of a new problem and there is no basis for presuming that associations existing at one scale will also exist at another.[2] Generally it is suggested that smaller the unit of analysis lesser the distortion of reality. Despite the broad truism of this axiom, scale is subject to restrictions in both upward and downward directions. Observation of characteristics and relationships over large areas runs into the risk of oversimplification and fallacious averaging of reality; whereas smaller units of analysis pose the problem of fragmentation as processes and relationships may cross their boundaries.

The soundness of a geographic analysis, therefore, depends on the extent to which a territory is subdivided and a criteria which is adopted for such a division. But such analyses usually proceed with the data collected by administrative apparatus for predetermined administrative units - which show no criteria in their division and aggregation other than physical propinquity. Therefore,

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2 McCarty, H.H., Hook, J.C. and Knos, D.S., The Measurement of Association in Industrial Geography, Department of Geography, State University of Iowa, San Francisco, 1964, p.50.

they lack homogeneity in size and composition and very often reflect variance in the details of available information at every level of aggregation. This problem was very strongly felt in the present study. The area under study is a small region consisting of four districts of Uttar Pradesh with a total area of 26,356 sq. km. The information available at this level is in abundance. However, there are many all India studies of agricultural productivity and development at this level. Therefore, a study of productivity at district level in the area under study will be simplistic and have no geographical value. On the other extreme village is the smallest unit. But considering paucity of data at this level and sheer number of units it is impossible to conduct a research on this level. Besides, relationships and processes over space at this level will be fragmented. Considering equality of size and homogeneity and contiguity of the socio-economic ana physical composition, development block[3] is considered a viable unit of analysis in the present study. The development block is an administrative

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3 A development block is an administrative unit consisting generally of 150 villages, covering approximately an area of 200 sq. km. For each development block there is a Block Development Officer.

unit which is considered a unit for development processes in agriculture. All agricultural development activities are organized on this unit. Therefore, it is an appropriate unit of analysis.

(iii) Selection of Variables

Regional development is a multidimensional concept. By its very definition there are many socio-economic and cultural variables which together define levels of development. Development can be measured as a process or as a state or in terms of conditions necessary for development. Since the purpose of the present analysis is to analyse development at a single point of time, the process variables of development are left out of account. Variables relating to conditions and state of development are selected. There are twenty variables in all. They are grouped under four heads: agricultural development, urbanization and industrialization, infrastructure and amenities and social development. As such, the measurement of the regional development exhibit conditions and state of development in different blocks.

(iv) Techniques of Analysis

In the present study two analytical concepts of agricultural productivity and levels of regional development are used. So far as agricultural productivity is concerned there is not a single universally accepted method of measuring agricultural productivity. Different scholars have used different numerical methods to measure levels of agricultural productivity, at small areal units. Kendall's ranking coefficient and Enyedi's productivity index are commonly used methods of rating sub-areas according to their agricultural productivity level. Kendall's method of ranking coefficient results in considerable information loss by ranking of yields of various crops, thereby only one rank difference is assigned to sub-areas without considering large or small magnitudes of variation. Moreover, it considers only per hectare yield of crops and does not take into account the areal strengths of crops. Enyedi's method is somewhat suitable but in some areal units it gives more productivity rating than that of the national level even the units have equal or even less yield than the national level. These considerations have led the researcher to use Bhatia's and Shafi's methods of productivity rating. These methods having been developed in India are more suitable to Indian specificities of agriculture. Besides, these two methods, other indices of agricultural productivity as Standard Nutrition Unit per hectare, agricultural output in Rs. per hectare and agricultural output in Rs. per agricultural worker are also used. Jasbir Singh also incorporated standard nutrition unit while measuring the agricultural efficiency of Haryana. For this purpose he included all the food crops and oilseeds grown in the area and calculated their caloric output. By these, he measured the carrying capacity per square mile which reflects the position of agricultural efficiency in an area.

Regional development as pointed out earlier is measured on the basis of twenty variables. The mapping and analysis parsimoniously of these variables is a difficult task. It involves classification of areas on the basis of these twenty variables. Appropriate operational techniques for this task are found in two research traditions in geography: multivariate regionalization and factorial ecology. The methodology of multivariate regionalization has developed and spread rapidly after the publication of Ginsburg's Atlas of Economic Development.[4]

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4 Ginsburg, N., Atlas of Economic Development, Chicago, 1961.

Many an earlier attempt has employed simple additive techniques involving ranking and classification of indicators according to some theoretically determined criteria. Later this methodology has been modified under 'social indicators' approach that reacted sharply to the overemphasis on economic criteria as the measure of human well-being. As a result, more and more social indicators have been incorporated in the regional analysis of the development. Since the relationship among these varied indicators of development have become uncertain by now, procedures of standardization have been adopted so that transformation of indicators may entail their addition into various categories of the development. Smith[5] provides an excellent example of this procedure.

The methodology of factorial ecology developed in early 1960's employs a variety of mathematically rigorous methods of factor analysis to reduce a large number of socio-economic and environmental indicators into a few underlying dimensions. Unlike the methodology of multivariate regionalization which structures variables

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5 Smith, D.M., The Geography of Social Well-Being in the United States, McGraw Hill, New York, 1973.

according to some theoretical constructs, it allows the constructs to emerge from the interrelations of the variables themselves. It starts with the matrix of intercorrelations of original variables from which such a set of smaller number of variables is derived that reproduce original relationships with the restriction that derived variables are independent (orthogonal) of each other. By combining standardized original variables and their loadings on computed variables (factors), original variables may be aggregated to exhibit regional distribution of the new variables.

The methods of classification of variables into major dimensions in the two traditions have their respective advantages. The additive method involves simple calculation and there is little ambiguity involved as all the subjective elements are usually known and made explicit. Moreover, since they imply no assumption of orthogonality of dimensions, relationships among them may be evaluated and analysed. Such methods of classification are quite valid, if theoretical constructs are acceptable and addition of the variables is legitimate. However, assignment of equal rank difference to varying magnitudes of a variable results in considerable loss of information. Standardization procedure, usually that of zero mean, and unit variance overcomes much of the loss of information. Nevertheless, simple addition without giving consideration to the significance of the constituent indicators of a dimension cannot represent a major part of the reality. This problem is largely solved by factor analysis because loadings of variables on a factor (dimension) are their weights which are derived from their factual interrelationships. But factor analysis procedure starts with a solution which is not mathematically unique.[6] Therefore, there is no assurance that factors obtained would conform to the theoretically relevant or most important aspect of the reality. Generally, apart from the first factor that is understood as an overall index, all other factors remain uninterpretable. Hence, factors are subjected to rotation to some theoretical criteria to make the factor structure more interpretable.[7] But at this stage problem becomes

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6 Gould, R.P., On the Geographical Interpretation of Eigen Values, Transactions of Institute of British Geographers, Vol.42, 1967, pp.53-86.

7 Ress, P.H., Factorial Ecology: Extended Definition, Survey and Critique of the Field, Economic Geography, Vol.47, 1971, pp.220-31.
Timms, D.W.G., Quantitative Techniques in Urban Social Geography, in R.J. Chorley and P.Haggett (eds.) Frontiers in Geographical Teaching, Methuen, London, 1965.
Johnston, R.J., Some Limitations of Factorial Ecologies and Social Area Analysis, Economic Geography, Vol.47, 1971, pp.314-23.
Janson, Carl-Gunnar, Some Problems of Ecological Factor Analysis, in M. Dogan and S. Rokkan (eds.), Quantitative Ecological Analysis in Social Sciences, Cambridge, Massachusettes, The M.I.T. Press, 1969, pp.301 41.

more complex. Factor loadings though remain orthogonal, factor score do not. Thus, at the final stage of this analysis ambiguity is involved in the interpretation of regional patterns of various dimensions.

In order to reduce variables of development into few underlying dimensions and to derive a single productivity index from the five agricultural productivity indices, the procedure of factor analysis is used in the present study. The hypothesis of relationship between agricultural productivity and levels of development is tested by using coefficient of product moment correlation (r) and coefficient of determination (r^2).

(v) Factor Analysis Employed

Two separate factor analyses were conducted. First analysis was performed on five different indices of agricultural productivity. The second analysis included twenty variables relating to the levels of development as defined by economic, technological and social variables in 117 development blocks of the area under study.

Computation for these analyses was carried on on the Aligarh Muslim University's VAX-11 computing system.

The program of the factor analysis available in the stored <u>Standard Subroutine Package</u> involves following steps:

1. Computation started with the transformation of original data matrix D for n observations on m variables into a standard score matrix Z of n x m order.

2. From the Z matrix an m x m order correlation matrix R was calculated which contained product moment correlation coefficients.

3. This correlation matrix was resolved into a factor matrix A of m x r where r was number of factor extracted. The program employed can extract as many factors as the number of variables. Therefore, in the first instance all the factors were extracted. Histogram of the cumulative percentages of the variance explained by the successive factors and cumulative number of factors was constructed. By inspecting rate of change in the explanation of variation by factors, number of factors to be retained was determined.

4. Since original variables retained were not readily interpretable, the factor loading matrix A was rotated according to normal varimax criterion to reproduce a new factor loading matrix. The criterion employed rotated

the factor matrix to such a position where a minimum possible number of variables loaded high on each factor. The factor structure, thus became simpler and easily interpretable.

5. From the matrix multiplication of standard score matrix of n x m order and rotated factor matrix A of m x r order, a factor score matrix F of n x r order was obtained. Factor scores were then standardized to zero mean and unit variance. These factor scores provided a measure of position of each block on the new factors.

ORGANIZATION OF THE STUDY

This work is organized into three parts, namely conceptual and methodological framework, the study area, and pattern of agricultural productivity and dimensions of regional development. The first part constitutes the theoretical base of the work and is related to concepts and methodology. It comprises three chapters. First chapter presents the conceptual framework of agricultural productivity. Second chapter is devoted to the methodology of measurement of agricultural productivity. In the third chapter focus is onto regional development elucidating concepts of regional development and its measurement.

The second part deals with the study area and comprises three chapters. The structure and relief, drainage and physical divisions are discussed in the fourth chapter. The fifth chapter embodies the description of climate. In the sixth chapter an account of soils is given.

The third part contains in three main chapters of the thesis. The chapter seven deals with the pattern of agricultural productivity. Dimensions of regional development are analysed in the eighth chapter. The ninth chapter of the thesis is devoted to the analysis of relationship between agricultural productivity and regional development in the area under study. In the conclusion suggestions have been made to minimize the regional disparities in the levels of agricultural productivity and regional development.

PART I

CONCEPTUAL AND METHODOLOGICAL FRAMEWORK

CHAPTER I

CONCEPT OF AGRICULTURAL PRODUCTIVITY

Productivity like disparity is a relative concept. The term productivity has been used in different meanings and has aroused many conflicting interpretations. Sometimes it is considered as the overall efficiency with which a production system works, while others it is defined as a ratio of output to resources expended separately or collectively. This term has also incorrectly and interchangeably been used with production. In reality, production refers to the volume of output while productivity signifies the output in relation to resources expended. Production can be increased by employing more resources without increasing productivity. On the other hand productivity can be increased without increasing production by employing less inputs for the same production level. But it is commonly agreed that productivity is the ability of a production system to produce more economically and efficiently. Therefore, agricultural productivity can be defined as a measure of efficiency with which an agricultural production system employs land, labour, capital and other resources.

In recent years many attempts have been made to define the connotation of agricultural productivity. According to Dewett (1966), "Productivity expresses the varying relationship between agricultural output and one of the major inputs, like land or labour or capital, *other complementary factors remaining the same* ..." It may be borne in mind that productivity is physical rather than a value concept.[1] The connotation of agricultural productivity engaged the attention of many an economist at the 23rd Annual Conference of the Indian Society of Agricultural Economics.[2] Some economists suggested, that the yield per acre should be considered to indicate agricultural productivity. A number of objections were raised against this view because it considered only land which is just one factor of production while other factors are also responsible, and therefore it was arbitrary to attribute productivity entirely to land and express it per acre of land. It was suggested, for instance, that productivity could also be measured in terms of per unit of labour and different regions compared on

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1 Dewett, K.K. and Singh, G., Indian Economics, Delhi, 1966, p.66.

2 Regional Variations in Agricultural Development and Productivity, Indian Journal of Agricultural Economics, Vol.19, No.1, 1964, pp.168-266.

that basis. After a thorough discussion, it was generally agreed that the yield per acre may be considered to represent the agricultural productivity in a particular region, and that other factors of production be considered as the possible causes for the variation while comparing it with the other regions.[3] Pandit (1965) has stated the connotation of productivity in these words, "Productivity is defined in economics as the output per unit of input... the art of securing an increase in output from the same input or of getting the same output from a smaller input".[4] He further suggests that increases in productivity, whether in industry or agriculture, is generally the result of a more efficient use of some or all the factors of production, viz. land, labour and capital. According to Saxon basically, productivity is a physical relationship between output and the input which gives rise to that output.[5] Horring[6] considers productivity, in broad terms to denote the ratio of output to any or all associated inputs, in real term.

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3 Summary of group discussion, Regional Variations in Agricultural Development and Productivity, ibid., pp.263-66.

4 Pandit, A.D., Application of Productivity Concept to Indian Agriculture, <u>Productivity</u>, Special issue on agricultural productivity, 6, (2 and 3) 1965, p.187.

5 Saxon, E.A., Special Concepts of Productivity, ibid, p.226.

6 Horring, J., Concept of Productivity Measurement on a National Scale, OECD, <u>Documentation in Food and Agriculture</u>, No.27, Paris, 1964, p.10.

There are many different concepts of productivity, and still diverse ways for computing it. The Chairman of the International Commission on Agricultural Typology, Kostrowicki, invited different views on this problem by sending a questionnaire to over 100 scholars throughout the world, which embodied, the following two questions:

1. What methods, of measuring intensity of agriculture should be applied in typological studies of various orders?
2. What methods, measures and indices should be used to define land, labour and capital productivity of agriculture in typological studies of various orders?

About fifty geographers from all over the world responded and suggested various approaches to the measurement of agricultural intensity and productivity. The Chairman of the commission while evaluating the different views pointed out, that a special study for testing various methods and techniques to be used in the studies of various scales were needed.[7]

Land, labour and capital are various aspects of agricultural productivity. These are the best known

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7 Proceedings of the International Commission on Agricultural Typology (unpublished), Warsaw, 1966.

partial productivity measures. 'Land' is viewed as area with different natural attributes. It realizes different rents and varies in purchase price. 'Labour' represents all human services other than decision making and 'capital' the non-labour resources employed by the farmer.

It is due to pressure of population that special attention is given to land productivity. It is the simplest but in some respects the most useful aspect of agricultural productivity. Maximum production from land can be achieved with available inputs of land measures that can fulfil the pressing demand of the day. Inevitably the inherent chemical and physical properties of the land vary spatially and impose varying limits on the agricultural use of the land, although actual use will be dependent upon technology, profit and cultural constraints.[8]

Land productivity is obviously of primary importance in countries with a high density of population. When land resources are limited the principal means of raising production to keep pace with the growth of population is by raising yields per hectare. However,

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8 Morgan, W.B. and Munton, R.J.C., Agricultural Geography, London, 1971, p.54.

raising the productivity of land does not mean only raising the yields of individual crops. It encompasses the whole output of a farm or country in relation to the total area of farm land, and may be raised also by changing the pattern of production toward more intensive systems of cultivation or toward higher value crops.

A distinction must be made between the measurement of agricultural output in terms of calories (or some other measurement of food values), and in terms of money values. For example, if in temperate countries land is shifted from cereals to potatoes the output per hectare in terms of calories of human food is likely to be increased. But its productivity in terms of money values may be changed up or down according to the relative prices of cereals and potatoes. Again, shifting land from the main crop potatoes to early season potatoes or to luxury vegetables may well increase its productivity in money terms, but will almost certainly reduce it in terms of calories. Good pasture land used for grazing will usually produce less in calories for human food than if cropped with cereals for direct consumption, but may well show higher productivity in money values.

The productivity of labour is a somewhat more complex aspect than land productivity. Labour productivity means the income of the population engaged in agriculture and can be measured in terms of output per worker. It takes into account all the labour which contributes to agricultural production, the labour that is used directly on the farm as well as that used indirectly off the farm in producing the materials and services used on agricultural production.[9] The labour input may be expressed as the total number in the labour force or, in order to take into account the intensity of labour, as the number of man-hours worked in agriculture. Similarly the total agricultural output may be taken as the gross farm output or it may be taken as the value added by labour and other factors in the agricultural sector; i.e. the value of fertilizers, pesticides, fuels and other inputs from outside the agricultural sector, is subtracted from the value of the output in order to determine the net contribution of the agricultural sector.[10]

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9 Folk Dovrings, Productivity of Labour in Agricultural Production, Agricultural Experimental Station Bulletin 726, Urbana, University of Illinois, College of Agriculture, September 1967.

10 FAO, The State of Food and Agriculture, Rome 1963, p.98.

Labour productivity is in fact the most common form of measurement, and is usually implied in economic discussions when no specific definition is given. In so far as the output per man is one of the major determinants of the general level of economic welfare, labour productivity is a significant yardstick of economic progress. Various measurements of labour productivity may, have specific uses in policy formation, e.g. with regard to income distribution, occupational distribution of labour force etc.[11]

Increases in the productivity of land and of labour often go hand in hand. When crop yields are increased or the pattern of cropping intensified there is usually - although not always - an increase in output per man. Similarly when improved methods are adopted to increase efficiency and raise labour productivity and farm incomes, there is often, as a secondary result, an increase in land productivity and total output. In countries with agricultural surplus problems this may be embarrassing, and increased labour productivity may then have to go hand in hand with measures to limit the area under cultivation.

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11 ibid., p.98.

Capital productivity of agriculture is particularly complicated to compute and difficult to interpret. This is largely because off diversity of capital being utilized in agricultural production: for land purchased for improvement, reclamation, drainage, irrigation, farm buildings, mechanical power, machinery and implements, livestock, feeds, seeds, fertilizers, crop protection chemicals etc. The presence or absence, amount, quality and price of each factor of production varies spatially, affecting the relationships between them and their deployment on individual farms. These spatial patterns are not static, labour and capital being geographically mobile. The use of each production factor will not depend solely upon its availability. It will be influenced by technological, economic and social circumstances which permit the substitution of one for another and in turn will be affected by their degree of divisibility.

Estimates of capital productivity give relatively little guidance in ensuring the most efficient use of the limited capital resources. In part this is because the statistics on capital in agriculture are less informative than those on land and labour, not because much of this investment, especially in less developed countries, consists of nonmonotized investment stemming from the unpaid labour of the farmers themselves. The terracing of slopes, the bunding of paddy fields, the construction of irrigation ditches are examples of this type of nonmonotized investment which is of crucial importance - for raising both output and productivity. This does not mean, of course, that capital is not of vital importance to agriculture. The requirements of fixed capital stock in agriculture - even excluding land - often appear to be greater in relation to the output than those of manufacturing industries and mining, though there are considerable differences between countries in methods of estimation.

The productivity of livestock is again more difficult to measure than the productivity of land. The difficulty arises both in the measurement of the input and the output. Much of the livestock production results in more than one end product: cattle may produce milk, beef and hides, sheep may produce wool and meat etc. A comparison of, say, the milk output of specialized dairy cows with that of dual purpose animals kept for both milk and beef may be misleading. To aggregate the output of all livestock products, with suitable price weights, solves part of the problem but not all of it, because of the widespread use of livestock, particularly in the less developed regions, for draft power. A complete accounting of the output would, therefore, also require the inclusion of the draft power produced by livestock. The principal input is the capital represented by the livestock itself. Other inputs include the feeding stuffs which they consume, whether from grazing or in the form of preserved or concentrate feeds, and the land which is pasture or cropland is devoted to livestock production.

The above measurements when combined shall not give a very satisfactory indication of productivity. The simplest and the most frequently used comparison is the output of milk or meat per animal, which would be significant when cattle are of about the same size or weight. But if in one country the common breeds of livestock are large and in another small, differences between the average output per animal in the two countries will in part reflect these differences in size rather than their relative efficiency. And since small cattle eat less and since more small cattle can be kept on a given area, the total output of meat or milk per unit of feed or per hectare of land may be as high in one country as in the other. It could not then be said that the average productivity of the larger breeds was greater than that of the smaller breeds.[12]

12 ibid., p.108.

The whole output from each hectare of land used for agriculture is known as the overall productivity of land. It is more significant than crop yields per hectare or livestock yields. The individual yields reflect only the efficiency of crop husbandry or livestock husbandry, the overall productivity also takes into account the managerial skill with which the various farm enterprises are integrated to increase the total farm output. The overall productivity reflects also the opportunities to produce high-value crops, e.g. tobacco, or in suitable climates or under irrigation to raise more than one crop per year from the same land. Thus, the countries with the highest total output per hectare appear to have an overall productivity some 40 times greater (exceptionally even more) than those with the least intensive agricultures.[13]

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13 ibid.; p.110.

CHAPTER II

THE MEASUREMENT OF AGRICULTURAL PRODUCTIVITY

The measurement of agricultural productivity is not a simple task as it involves a relationship between inputs and output in agricultural production. Input itself is a complex thing which governs farming efficiency. Stamp while attempting to measure crop productivity per unit area emphasized that areal differences in crop productivity are the result partly of natural advantages of soil, and climate and partly of farming efficiency.[1] Farming efficiency refers to the properties and qualities of the various inputs, the manner in which they are combined and utilized for production and effective market demands for the output.

There is a substantial literature relating to methodological procedures for measuring productivity

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1 Stamp, L.D., Our Developing World, London, 1960, p.108.

in agriculture.[2] The measures of agricultural productivity which are most frequently understord are those of partial

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2 Raising agricultural productivity in developing countries through technological improvement, The State of Food and Agriculture, FAO, 1968; Folke Dovring, Productivity of labour in agricultural production, Agricultural Experimental Station Bulletin, No.726, Urbana, University of Illinois College of Agriculture, September 1967; Durost, D.D., and Barton, G.T., Changing sources of farm output, Production Research Report, No.36, USDA, Agricultural Research Service, Washington, D.C. 1960; Horring, J., Concept of productivity measurements in agriculture on a national scale, OECD, Documentation in Food and Agriculture, No.57, Paris, 1964; Kendrick, J.W., Productivity trends in the United States, General Series, No.71, Princeton, National Bureau of Economic Research, 1961; Loomis, R.A. and Barton, G.T., Productivity of Agriculture in the United States, 1870-1958, Technical Bulletin, No.1238, USDA, Agricultural Research Service, Washington, D.C., 1961; The State of Food and Agriculture, FAO, Rome, 1963; Hayami, Y. and Ruttan, V.W., Agricultural productivity differences among countries, The American Economic Review, Vol.60, No.5, 1970; Shishido, T., Japanese Agriculture: Productivity Trend and Development of Technique, Journal of Farm Economies, Vol.43, 1961; Van den Noort, P.C., Agricultural Productivity in Western Europe, Netherlands Journal of Agricultural Science, Vol.15, No.2, 1967; Symposium on Measurement of Agricultural productivity, Journal of Indian Society of Agricultural Statistics, Vol.17, No.2, 1965; Regional Variations in Agricultural Development and Productivity, Indian Journal of Agricultural Economics, Vol.19, 1964; Productivity, Special Issue on Agricultural Productivity, National Productivity Council Journal, Vol.6, Nos.2 and 3, 1965; The State of Food and Agriculture, FAO, Rome, 1970.

productivity and refer to the relation of a single input or a group of inputs to the total output or to a part thereof (yield per hectare, output per man- hour, output per unit of capital). The data required to measure the productivity of a single input are more likely to be available than are those required for measures of overall productivity. Besides, the aggregate of total inputs may tend to obscure the effect of changes in their composition. Many attempts have been made to measure the agricultural productivity in various countries of the world.

Thompson[3] (1926) while measuring the relative productivity of British and Danish farming emphasized and expressed it in terms of gross output of crops and livestock. He considered seven parametres. They are: (i) the yield per acre of crops, (ii) the livestock per 100 acres, (iii) the gross production or output per 100 acre, (iv) the proportion of arable land, (v) the number of persons employed, (vi) the cost of production expressed in terms of wages and labour costs, rent or interest, and (vii) prices relative profitability and general economic conditions.

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3 Thompson, R.J., The Productivity of British and Danish Farming, Journal of the Royal Statistical Society, 89, Part II, 1926, p.218.

Ganguli[4] (1938) in his study of the Ganges Valley presented a theoretical discussion for computing productivity in agriculture. Firstly, he took into account the area under any crop 'A' in a particular unit area belonging to a certain region. This area is expressed as a proportion of the total cropped area under all the selected crops. Secondly, Ganguli tried to obtain the index number of yield. This is found by dividing the yield per hectare for the entire region as the standard. This yield may be expressed as a percentage and the percentage may be regarded as the index number of yield. Thirdly, the proportion of the area under A and the corresponding index number of yield were multiplied. There are two advantages which are apparent by using this method, i.e. (a) the relative importance of the crop A in that unit of study is assessed as indicated by the proportion of the cropped area which is under A, and (b) the yield of the crop A in comparison to the regional standard. The product thus obtained indicates actually an index of the contribution of the crop A to the productivity of the unit considered.

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4 Ganguli, B.N., Trends of Agriculture and Population in the Ganges Valley, London, 1938, p.93.

Kendall[5] (1939), taking the acre yield of ten leading crops in each of the forty eight administrative counties in England for four selected years, tried on four coefficients: productivity, ranking, money value and starch equivalent or energy. Of the four coefficients, the ranking coefficient is probably the easiest to calculate and gives a reasonable ranking of counties in order of productivity. To obtain the ranking coefficient, Kendall ranked each of the ten crops in the forty eight counties in order of their yield, then the sum of the ranks occupied by the unit was divided by the number of the crops considered to obtain the average rank of the unit. Kendall's money value coefficient was based on the value of crop production of each county (which was obtained by multiplying the volume of production of a particular crop by the price) and the results of ten crops for each county were added together and the total was divided by the total acreage in the county under the ten crops. Kendall's energy coefficient is based on the total energy value of various arable crops expressed as starch after adding the proportions

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5 Kendall, M.G., The Geographical Distribution of Crop Productivity in England, Journal of the Royal Statistical Society, Vol.52, 1939, pp.21-48.

assignable to by- products and the energy index was constructed by ascertaining the production of energy per acre under crops on the basis of a prepared table showing the energy value of various crops.

Kendall's money value coefficient poses one major difficulty, that data for certain crops are not available, for example, there are many vegetables and beans which are grown mostly for the consumption on the farms and their price data are not recorded in contrast to cereal crops whose data are adequate. While determining the money value coefficient, another difficulty arises with regard to the prices - for example, the prices prevailing in the area should be adopted, or those prevailing in the region or in the country as a whole, in addition to the local variations in the prices which depend on circumstances like, proximity to the market or the relative nutritive character of the product. Significant differences in prices per tonne between the crops affect the final result heavily in favour of the higher priced commodity. In this method, the crop production of each unit area is valued by multiplying the volume of production of a particular crop by the price, and then add the results for the selected number of crops together. The total is divided by the total acreage in the unit area under the total selected crops. The result gives for each unit area a figure of money value per acre/hectare under the crops considered. So far as energy coefficient is concerned, an index based on nutritional factor ignores local variations because of the absence of data. Kendall, therefore, suggests starch equivalent as the most suitable unit. While calculating a coefficient based on starch equivalent it should be decided: (a) whether a gross or net digestible energy figure is to be taken, (b) whether any allowance is to be made for by-products, such as - wheat and barley straws or the green stalks of maize, jowar and bajra, and (c) whether any account should be taken of the fact that the energy in certain foods has first to be fed to livestock and then wheat and milk is used for human consumption. The basic question that arises in this technique is whether the gross starch equivalent of the various crops should be considered or the net equivalent. Net energy refers to the amount of energy for work and body building whereas, a gross figure includes the energy employed in the digestive process of the consuming animal and similar non-realisable forms. Kendall suggested, that production of energy be preferred as the gross figures.

Hirsch[6] (1943) has suggested 'Crop Yield Index' as the basis of productivity measurement. It expresses the average of the yields of various crops on a farm or in a locality relative to the yields of the same crops on another farm in a second locality. Zobel[7] (1950) has attempted to determine the labour productivity. He considered the productivity of labour as the ratio of total output to the total man-hours consumed in the production of that output resulting in output per man-hour. This has been expressed by the following equation:

$$\pi = f(P, L)$$

where

π = productivity of labour,

P = production, and

L = labour utilized.

Huntington and Valkenburg[8] (1952) considered land productivity on the basis of acre yields of eight crops raised very widely in Europe. For each crop, the

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6 Hirsch, H.G., Crop Yield Index, Journal of Farm Economics, 25 (3), 1943, p.583.

7 Zobel, S.P., On the Measurement of Productivity of Labour, Journal of American Statistical Society, 45, 1950, p.218.

8 Huntington and Valkenburg, Europe, New York, 1952, p.102.

average yield per acre for Europe as a whole was taken as an index of 100, and the specific yield in each country was calculated accordingly. Stamp[9] (1952) adopted Kendall's ranking coefficient by selecting twenty countries and nine crops. The countries were placed in order of output per acre for each crop. The places occupied by each country in respect to the selected crops were then averaged, and from these averages, the ranking coefficient of agricultural efficiency of each country was obtained. If a country was at the top of every list, it would have a ranking coefficient of one, and if it were at the bottom of every list, it would have a ranking coefficient equal to the total number of countries concerned.

Another approach to measure productivity is to convert the total food production into calories. Quantitative food requirements are usually estimated in terms of

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9 Stamp, L.D., The Measurement of Agricultural Efficiency with Special Reference to India, Silver Jubilee Souvenir Volume, Indian Geographical Society, 1952, pp.177-78.

heat units — calories.[10] A physiological calorie (also called kilocalorie and abbreviated Kcal) is the amount of heat necessary to raise the temperature of one kilogram of water by one degree centigrade. The caloric intake is a measure of the general health of a person because it determines the amount of heat and energy needed by the human body.

Stamp[11] (1958) has taken calorific value of farm production in measuring the agricultural productivity. He calculated the Standard Nutrition Unit (SNU) by converting all the food production per acre in calories. The British Medical Association has carried out an exhaustive enquiry based on all available sources and published a table to show the caloric intake among adults

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10 A recommendation was made recently by international organizations like the FAO, WHO and the International Union of Nutritional Sciences that the unit 'joule' should be used instead of calorie for expression of energy values. The new units Kilojule (KJ) and Megajoule (MJ) may, therefore, eventually replace the Kilocaloric used now for expressing the energy value of foodstuffs. The relationship between the two units is as follows:

1 Kilocalorie = 4.184 Kilojules (KJ)
(physiological calories) or 4,184 joules.
1000 Kilocalories = 4.184 Megajoules (MJ)

In Nutritive Value of Indian Foods by Gopalan, C. and others, National Institute of Nutrition, I.C.M.R., Hyderabad, 1980, p.9.

11 Stamp, L.D., The Measurement of Land Resources, The Geographical Review, Vol.48, No.1, 1958, p.3.

from 2,100 a day for a woman in sedentary occupation to 4,250 for a man engaged in active mannual work. For children the desirable intake is calculated at 800 a day for infants under one year to 3,400 for teenage boy. The average of the different categories worked out at 2,540 calories a day. Taking into consideration the age structure of the population, the range of occupations, the weight and height of the people living under the climatic conditions of north western Europe, the average is 2,460 calories a day or about 9,00,000 calories per year. Making allowance for a loss of 10 per cent in harvesting, cooking and food preparation the figure of 10,00,000 calories a year in terms of farm production may be accepted.[12]

The Nutrition Expert Group of Indian Council of Medical Research has recommended the daily allowances of Nutrients for Indians. They published a table to show the caloric intake among adults from 1,900 a day for a woman in sedentary work to 3,900 for a man engaged

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12 Stamp, L.D., Our Developing World, London, 1960, p.110.

in heavy work. For children it was recommended 110 calories per kg weight of the body per day for infants under one year to 3,000 for teenage boy.[13]

Shafi[14] (1960) has calculated this under Indian conditions in the twelve villages of Eastern Uttar Pradesh. The net caloric intake ranges from 1,828 a day (667,677 a year) to 2,175 a day (795,514 a year). According to him in no case it reaches the 9,00,000 calories postulated as the Standard Nutrition Unit. He concluded that in the well drained and irrigated villages of Eastern Uttar Pradesh the caloric intake per person amounts to about 2,000 a day. Where the caloric intake drops below 2,000 a day, both standard of living and standard of health are perceptibly lower.

Loomis and Barton[15] (1961) have measured United States agricultural input and productivity in aggregate.

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13 Gopalan, C. and Others, op. cit., p.27.

14 Shafi, M., Land Utilization in Eastern Uttar Pradesh, Aligarh, 1960, p.222.

15 Loomis, R.A. and Barton, G.T., Productivity of Agriculture in the United States 1870-1958, Technical Bulletin No.1238, USDA, Washington, D.C., 1961, p.1.

To them, aggregate productivity depends upon conceptually consistent measures of agricultural output and input. The measures of inputs include all the production factors that depend directly on the decisions of farmers. Meiburg and Brandt[16] (1962) have surveyed the earlier indices relating to the United States agricultural output, e.g., output estimates of total productivity. They considered eight indices of agricultural production which cover various phases of the period extending between the years 1866 and 1960. Mackenzie[17] (1962) has measured the efficiency of production in Canadian agriculture by using the coefficient of output relative to input. He mentions, that the concept of productivity measurement is difficult to define and even more difficult to quantify. Commen[18] (1962) while working out the trends of productivity in agriculture of the state of Kerala (India) has measured productivity on the basis of yield

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16 Meiburg, C.O. and Brandt, K., Agricultural Productivity in the United States: 1870-1960, Food Research Institute Studies, 3 (2), 1962, p.64.

17 Mackenzie, W., The Impact of Technological Change on the Efficiency of Production in Canadian Agriculture, Canadian Journal of Agricultural Economics, (1), 1962, p.41.

18 Commen, M.A., Agricultural Productivity Trends in Kerala, Agricultural Situation in India, 17 (4), 1962, pp.333-36.

per acre. Enyedi[19] (1964) while describing geographical types of agriculture in Hungary used the following formula for determining agricultural productivity.

$$\frac{Y}{Yn} : \frac{T}{Tn}$$

where

- Y = total yield of the respective crop in the unit area,
- Yn = total yield of the crop at the national level,
- T = total cropped area of the unit,
- Tn = total cropped area at the national level.

Horring[20] (1964) has suggested that the concept of productivity is based not only on the single relationship between output and input, but rather on the differences between two or more relationships, i.e. differences in the same agricultural region or sub-region as between successive periods (in time), and between similar agricultural regions in different countries or regions

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19 Enyedi, G.Y., Geographical Types of Agriculture, Applied Geography in Hungary, Budapest, 1964, p.61.

20 Horring, J., Concept of Productivity Measurement in Agriculture on a National Scale, OECD, Documentation in Food and Agriculture, 57, Paris, 1964, p.10.

during the same period (in space). It may also be possible to make comparisons between the trends of productivity for different products, between different regions of the national economy or between the agricultural regions and the national economy as a whole.

The Indian Society of Agricultural Economics, considered the problem and published a series of articles under the broad head 'Regional Variations in Agricultural Development and Productivity'.[21] Among the contributors Chaterji and Maitreya[22] (1964) have determined the levels of agricultural development and productivity during 1950-51 to 1957-58 in the state of West Bengal taking two crops (rice and jute) in consideration. They utilized the acre yield figures for this purpose. Dhondyal[23] (1964) has measured variations in agricultural development and productivity by selecting three representative district from the three regions of the Uttar Pradesh, while assessing

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21 Indian Journal of Agricultural Economics, 19 (1), 1964, pp.168-266.

22 Chaterji, A. and Maitreya, P., Some Aspects of Regional Variations in Agricultural Productivity and Development in West Bengal, ibid., pp.207-12.

23 Dhondyal, S.P., Regional Variations in Agricultural Development and Productivity in the Eastern and Western Regions of Uttar Pradesh, ibid., pp.193-97.

the role of credit, intensive crop interprises, and the influence of irrigation water during 1962-63.

Garg[24] (1964) worked out the trends in agricultural development with respect to total cropped area, gross irrigated area and foodgrain production in the two districts of Uttar Pradesh, viz. Gorakhpur representing the eastern region and Meerut from the western region and productivity by assessing acreage, production and average yield per acre of three important crops, viz. rice, wheat and sugarcane. This study extends from 1951-52 to 1960-61 covering the period between the First and Second Five Year Plans. Gopalkrishnan and Ramakrishna[25] (1964) have taken Andhra Pradesh (1) to measure the degree of variations with respect to (a) agricultural output per acre (Rs.), (b) output per head of agricultural population (Rs.), and (2) to account the causes of variations in each of twenty districts of the state during 1959-60. The variables relating to the level of output per acre are selected as follows: (i) normal level of rainfall, (ii) percentage of current and old

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24 Garg, J.S., Variation Studies in the Agricultural Development and Productivity in the Eastern and Western Regions of Uttar Pradesh, ibid., pp.193-97.

25 Gopalkrishnan, M.D. and Ramakrishna, P.T., Regional Variations in Agricultural Productivity in Andhra Pradesh, ibid., pp.227-36.

fallows, (iii) percentage of area under irrigation, (iv) percentage of literacy, (v) percentage of population in agriculture, (vi) intensity of cropping, (vii) percentage of gross value other than foodgrains and fodder, (viii) the percentage of area under all crops excluding fodder and foodgrains, (ix) density of agricultural population per acre, and (x) percentage of total area under commercial crops including rice.

Sapre and Deshpande[26] (1964) modified the Kendall's ranking coefficient by giving weightage to the area under different crops. The weights for ranks of various crops are proportional to the percentage of cropland under each crop. For example, an enumeration unit 'A' has rank 2 on the basis of wheat acre-yield and occupies 30 per cent of the total cropped area, rank 3 on the basis of rice acre-yield and occupies 25 per cent of the total cropped area, rank 8 on the basis of gram acre-yield and occupies 10 per cent of the total cropped area. Thus the weighted average of the ranks would be: (2 x 30) + (3 x 25) + (8 x 10) = 215 divided by the sum of the weights as 215/65 = 3.3. According to Kendall's method it would have been 2+3+8 = 13 divided by the number of crops as 13/3 = 4.3.

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26 Sapre, S.G. and Deshpande, V.D., Inter-District Variations in Agricultural Efficiency in Maharashtra State, ibid., p.243.

The Indian Society of Agricultural Statistics, organized a symposium on the topic, 'Measurement of Agricultural Productivity' at the 17th annual conference of the society held at Jaipur in 1964. The research papers contributed by different scholars appeared in the Society's journal, viz., Journal of the Indian Society of Agricultural Statistics, in the succeeding issue of 1965. Sarma[27] (1965) while defining the concept of agricultural productivity has suggested various parameters on which it can be measured. According to him, productivity can be considered in relation to land, labour and capital. It can also be considered in terms of overall resources employed in agriculture. In case of commodities like foodgrains, fruits and vegetables sugarcane, and edible seeds, he suggests that the output of these commodities be converted into calories. While considering the other non-food crops such as cotton and other fibers the only common measure being the value which involves the pricing of different products. For evaluating value of production, farm harvest or wholesale prices have the definite

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27 Sarma, J.S., Measurement of Agricultural Productivity - Concepts, Definitions, etc., Journal of the Indian Society of Agricultural Statistics, 27 (2), 1965, pp.253-57.

significance. He also emphasised agricultural workforce as the basis of productivity measurement e.g., the total number of labourers employed (in order to account the intensity of labour) or the number of man-hours worked in agriculture per unit of area.[28]

Khusro[29] (1965) has linked assessment of productivity with the output per unit of a single input and output per unit of cost of all inputs in the agricultural production. Saran[30] (1965) has applied Cobb-Douglas 'Production Function' approach for the measurement of productivity. The common purpose of this function is to express input/output relationship between several inputs and one output in the agricultural systems. The function takes the following form:

$$Y = Ax_1^b \; x_2^c \; x_3^d \; x_4^e \; \ldots \; x_n^y \ldots$$

where x_1, x_2, x_3, x_4 ... n denote various inputs, like land, labour, capital and other working expenses. The

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28 ibid., p.254.

29 Khusro, A.M., Measurement of Productivity at Macro and Micro Level, ibid, p.278.

30 Saran, R., Production Function Approach to the Measurement of Productivity in Agriculture, ibid., p.268.

values of b, c, d... y represent elasticities of the respective inputs. Tambad[31] (1965 and 1970) has adopted 'Crop Yield Index' as the basis for measuring agricultural productivity. He explains, that the purpose of this technique is to express the average yield of various crops on a farm or in a region relative to the yield of same crops on an another farm or in a second region. It can be expressed by the following equation:

$$\text{Crop Yield Index} = \frac{\sum_{i=1}^{n} \frac{Y_i}{Y_{io}} A_i}{\sum_{i=1}^{n} A_i}$$

where

i = 1, 2, 3....... n are the number of crops considered in an unit area or year,

Y_i = is the yield per acre of crop i, in a farm area or year,

A_i = is the weightage of crop i, denoted by the area under the crop as a percentage of total cropped, and

Y_{io} = is the average yield per acre of crop i, at the group of farms, or entire region or the base year.

31 Tambad, S.B., Spatial and Temporal Variations in Agricultural Productivity in Mysore, Indian Journal of Agricultural Economics, 20, 1965, p.41.
Tambad, S.B. and Patel, K.V., Crop Yield Index as a Measure of Productivity, Economic and Political Weekly, 5 (25), 1970, pp.878-79.

Shafi[32] (1965) has assessed the productivity on the basis of labour population engaged in agriculture. According to him, it can be computed by dividing the gross production in an unit area by the number of man-hours or less precisely by the numbers employed in agriculture. In order to assess the productivity on the basis of population engaged in agriculture it can either be obtained by dividing the total production with the number of workers, or a reverse index be applied where the total number of workers per unit of production is assessed.

Agarwal[33] (1965) has adopted, 'Factorial Approach', while measuring agricultural efficiency in Bastar district of Madhya Pradesh. In this approach a number of human controlled factors relating to agricultural production as: crop superiority, crop commercialisation, crop security, land use intensity and power input have been selected, excluding the environmental factors.

Buck[34] (1937) assessed the agricultural progress in China by adopting the approach of 'Grain Equivalent'.

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32 Shafi, M., Approaches to the Measurement of the Agricultural Efficiency, Unpublished Proceedings of the Summer School in Geography held at Naini Tal, Department of Geography, Aligarh Muslim University, Aligarh, 1965, p.4.

33 Agarwal, P.C., Measurement of Agricultural Efficiency in Bastar District: A Factorial Approach, ibid.

34 Buck, J.L., Land Utilization in China, I, Nanking, 1937.

For this purpose he converted all the agricultural products into kilograms of grain equivalent in order to select as a unit of measure a kilogram, with whatever kind of grain was predominant in the region. A modification in this method was attempted by Clark and Haswell[35] (1967) by expressing the output in terms of kilograms of 'wheat equivalent' per head of population.

Dovring[36] (1967) has measured the productivity of labour in the United States agriculture in aggregate since 1919 to 1954 as a whole, as well as commodity-wise. Bhatia[37] (1967) while assessing the changes and trends in agricultural efficiency in Uttar Pradesh during 1953-1963 adopted Ganguli's method of productivity measurement and has devised an equation which would be read thus:

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35 Clark, C. and Haswell, M., <u>The Economics of Subsistence Agriculture</u>, London, 1967, pp.51-52.

36 Dovring, F., Productivity of Labour in Agricultural Production, <u>Agricultural Experiment Station Bulletin No.726</u>, College of Agriculture, Urbana, Illinois, 1967.

37 Bhatia, S.S., Spatial Variations Changes and Trends in Agricultural Efficiency in Uttar Pradesh, 1953-63, <u>Indian Journal of Agricultural Economics</u>, 22 (1), 1967, pp.66-80.

(i) $Iya = \frac{yc}{yr} \cdot 100$

where

Iya = is the yield index of crop a,

yc = is the average acre yield of crop a in the component unit, and

yr = is the average acre yield of crop a in the entire region.

and

(ii) $$Ei = \frac{Iya.\ Ca + Iyb\ .\ Cb + \ldots\ldots.\ Iyn.Cn}{Ca + Cb + \ldots\ldots\ldots.\ Cn}$$

where

Ei = is the agricultural efficiency index

Iya, Iyb etc. = are the indices of various crops, and

Ca, Cb, etc.= represent the proportion of cropland devoted to different crops.

Shafi[38] (1967 and 1969) applied Stamp's 'Standard Nutrition Unit' technique for measuring the efficiency of agriculture in India. He has considered the

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38 Shafi, M., Food Production Efficiency and Nutrition in India, The Geographer, 14, 1967, pp.23-27.

idem Can India Support Five Times Her Population? Science Today, 3, 1969, pp.21-27.

district as the areal unit, and has selected all the food crops grown in India. Noort[39] (1967) considered 'net total productivity' (being the relationship between the net product and factor input) as a method for the measurement of field productivity and also to assess comparisons 'in time' or 'in space'. The purpose of this measure is to account changes in labour and capital inputs in agriculture.

Sinha[40] (1968) has adopted a standard deviation formula to determine agricultural efficiency in India. In the study he selected all the twenty five major crops grown in the country which were grouped into cereals, pulses, oilseeds and cash crops and specific yields per hectare of cereals, pulses and oilseeds were taken. In case of cash crops, their monetary values were calculated (in Rs.) per hectare by incorporating wholesale market prices. Finally, the standard scores were computed and to give them weightage, these values were multiplied by the acreage figures, i.e., the area of cultivation under the crops.

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39 Noort, P.C. van den, Agricultural Productivity in Western Europe, Netherlands Journal of Agricultural Science, 15 (2), 1967, p.166.

40 Sinha, B.N., Agricultural Efficiency in India, The Geographer, Special Number, XXI, IGC, 15, 1968, pp.101-27.

Shafi[41] (1972) while measuring the agricultural productivity of the Great Indian Plains modified the Enyedi's formula. In the modified formula the summation of the total yield of all the crops in the district is divided by the total area under the crops considered in the district and the position thus obtained is examined in relation to the total yield of all the crops considered at the national level divided by the total area under those crops. The formula would be read thus:

$$\left(\frac{yw}{t} + \frac{yr}{t} + \frac{ymi}{t} \ldots\ldots n \right) : \left(\frac{Yw}{T} + \frac{Yr}{T} + \frac{Ymi}{T} \ldots\ldots \right.$$

or

$$\frac{\sum^{n} y}{t} : \frac{\sum^{n} Y}{T}$$

where

$yw, yr, ymi \ldots n$ = total yield of various crops in the district.

$Yw, Yr, Ymi \ldots n$ = total yield of the various crops at the national level.

t = total area under different crops in the district and

T = total area under different crops at the national level.

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41 Shafi, M., Measurement of Agricultural Productivity of the Great Indian Plains, The Geographer, 19 (1), 1972, pp.7-9.

Singh[42] (1972) has attempted to measure the agricultural efficiency of Haryana in terms of nutrition units per unit area. He has tried to measure the carrying capacity per square mile in the area unit which can be expressed as:

$$Cp = \frac{Co}{Sn}$$

where

Cp = carrying capacity

Co = caloric output per square mile

Sn = standard nutrition for ingestion in calories per person/annum.

He expressed it as a percentage of the carrying capacity in the entire region to obtain index numbers, which give a measure of the agricultural efficiency of the areal unit relative to the entire region. The above may be expressed as:

$$Iae = \frac{Cpe}{Cpr} \times 100$$

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42 Singh, J., A New Technique for Measuring Agricultural Efficiency in Haryana, <u>The Geographer</u>, 19 (1), 1972, pp.14-33.

where

Iae = the index number of agricultural efficiency of an enumeration unit.

Cpe = the carrying capacity in terms of population in the component enumeration unit.

Cpr = the carrying capacity in the entire region.

The Indian Society of Agricultural Statistics in its 30th Annual Conference held at Bhubaneswar (Orissa) India, discussed some aspects on agricultural productivity in the Indian context.[43] Raheja[44], et al. (1977) have measured the impact of high-yielding varieties based on data collected under the scheme, 'Sample Surveys for Assessment of High-yielding Varieties Programme', during 1973-74 and regional variations in productivity on the basis of yield per hectare in India. Singh[45] et al. (1977) have accounted the level of increase in the yield of different crops during three decennial years i.e., 1950-51, 1960-61 and 1970-71 in each state of India, considering

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43 Symposium on Regional Imbalances and Economic Development with Special Reference to Agriculture, Journal of the Indian Society of Agricultural Statistics, 29 (1), 1977, pp.109-24.

44 Raheja, S., et al., Factors Contributing to Regional Variations in Productivity and Adoption of High-Yielding Varieties of Major Cereals in India, ibid., pp.112-13.

45 Singh, D., et al., Crop Productivity Variation in India, op. cit., pp.113-15.

the relationship between the output of foodgrains and related inputs like, the application of fertilizer, proportion of area sown more than once and gross irrigated area.

Nangia et al.[46] (1977) conducted a field survey in the village Khandewala, of Haryana state, The study takes into account the productivity levels at different fields of the village in terms of money value during 1974-75 and a number of factors enumerated in three broad categories, viz. environmental, technological and institutional which hold responsibilities for the productivity variations. Bhalla[47] (1978) has considered output per person on constant average price for measuring productivity of labour in Indian agriculture in order to account for nineteen crops during the trienniums 1962-65 and 1970-73 for each district of India.

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46 Nangia, S., et al., Variations in Field Productivity - A Case Study of Khandewala, Haryana, Occasional Papers No.7 (Mimeo), Centre for the Study of Regional Development, Jawaharlal Nehru University, New Delhi, 1977.

47 Bhalla, G.S., Spatial Patterns of Agricultural Labour Productivity, Yojana, 22 (3), 1978, pp.9-11.

Singh[48] (1979) devised a method of presenting a two-dimensional picture of agricultural productivity comprising two components viz., intensity and spread considering three variables (i) yield, (ii) grain equivalent, and (iii) cropping system in the districts of the State of Andhra Pradesh. Accordingly, a relative share of intensity and spread for each micro unit (district) has been computed to the macro unit (state) separately for the above three variables with the help of equations that have been derived.

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48 Singh, V.R., A Method for Analysing Agricultural Productivity, Agriculture and Food Supply in Developing Countries (ed., J.T. Coppock), Published for the Commission on World Food Problems and Agricultural Productivity of the IGU, Department of Geography, University of Edinburg, 1979, pp.143-51.

CHAPTER III

CONCEPT OF REGIONAL DEVELOPMENT AND ITS MEASUREMENTS

Regional research and regionalization are classic themes of geography. Ideas of spatial development compose the core of the theoretical basis of geography. However, in the epoch of scientific and technological revolutions the very concepts of 'development' and 'space' undergo transformation, this being reflected in changes of concepts in the sciences investigating these phenomena and processes. The present chapter is an attempt to elucidate the concepts of 'development' and 'regional development' by tracing recent advances in this field. Since 'development' occurs in different socio-economic settings and takes different forms at national and regional levels specific to historical and socio-economic circumstances prevailing there, therefore, a synoptic review of studies of regional development is also made in the last section of the chapter.

THE CONCEPT OF DEVELOPMENT

'Development' is a multidimensional process. There are therefore, many interpretations of it. In geographical literature during the late 1970s and early 1980s, there have come up certain works which attempt to define development. Notable examples include Brookfield's[1] (1975) Interdependent Development, Roberts's[2] (1978) Cities of Peasants, Mabogunje's[3] (1980) The Development Process: a Spatial Perspective, Chisholm's[4] (1982) Modern World Development: a Geographical Perspective, and Harriss's[5] (1982) Rural Development: Theories of Peasant Economy and Agrarian Change. Each presents its own, very different view of 'development' and each provides a particular perspective from which future research can take its course. Mabogunje has identified four main ways in which the term 'development' has been used: development as economic growth, as modernization, as distributional

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1 Brookfield, H., Interdependent Development, Methuen, London, 1975.

2 Roberts, B., Cities of Peasants: the Political Economy of Urbanization in the Third World, Edward Arnold, London, 1978.

3 Mabogunje, A.L., The Development Process: a Spatial Perspective, Hutchinson University Library, London, 1980.

4 Chisholm, M., Modern World Development: a Geographical Perspective, Hutchinson University Library, London, 1982.

5 Harriss, J. (Ed.), Rural Development: Theories of Peasant Economy and Agrarian Change, Hutchinson University Library, London, 1982.

justice and as socio-economic transformation. He argues that for a long time following the Second World War development was seen simply as economic growth; it implied a rapid rise in productivity per capita, and a changed economic structure. Hodder[6] (1968) thus concentrated on economic development in his book on the tropics, and Chisholm[7] (1982) has recently described development as "a term used to signify an evolution of the economic structure accompanying expansion in total output."

Chisholm[8] (1982) goes on to distinguish between 'development' and 'modernization', the latter being seen as "the social transformation of a nation". For Mabogunje[9] (1980) this is the second way in which the word 'development' has been used: Development, still in the sense of economic growth, came to be seen as part of a much wider process of social change described as modernization. Lipton[10] (1977) has thus, for example, seen "development as modernising structural change". However, Mabogunje[11] (1980) also

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6 Hodder, B.W., Economic Development in the Tropics, Methuen, London, 1968.

7 Chisholm, M., op. cit., p.14.

8 ibid., p.14.

9 Mabogunje, A.L., op. cit., p.38.

10 Lipton, M., Why Poor People Stay Poor: Urban Bias in World Development, Temple Smith, London, 1977.

11 Mabogunje, A.L., op. cit., pp.38-39.

points out a crucial aspect of this view of 'development' as modernization, in that"to be modern meant to endeavour to consume goods and services of the type usually manufactured in advanced industrial nations". He goes on to observe that more recently development has been identified with distributional justice: as a way of reducing the poverty level among the masses or, as it was more succinctly put, satisfying their 'basic' needs (Mabogunje, 1980).[12] For this to be successful the concept of accessibility was crucial, and much attention was therefore paid to an analysis of the access of the poorest of the poor to 'resources' defined in the broadest of terms. In his last category of views of development, Mabogunje[13] (1980) suggests that "scholars of a Marxist philosophical persuation argue that the questions of distribution and social justice cannot be considered or resolved independently of the prevailing mechanisms governing production and distribution". This, Mabogunje argues, gave rise to dependency theory, in which development and underdevelopment are seen as being totally interrelated and also to an emphasis on three broad issues: the fact

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12 ibid., p.39.
13 ibid., p.42.

that development is a human issue, its requirements of the full mobilization of society and the idea of development as a redefinition of a country's international relations. In this vein Roberts[14] (1978) has advocated that "Development is an interdependent process in which some countries and regions acquire a predominant place within the divisions of labour, using coercion to organize production elsewhere, as in the case of colonialism, or control of capital or advanced technology and markets.... This situation is expressed in two related concepts that of dependency and that of the core - periphery relationship".

To these four basic concepts of 'development' Mabogunje[15] has added his own, a fifth, which sees "development as essentially a socio-spatial process". He himself sees "the development process as one of spatial organization. The reorganization arises as a result of the fact that development implies the articulation of a new set of social goals". While Mabogunje's classification provides a useful framework for viewing the nature of work done on 'development', it does not seriously question the use of the term 'development' itself. For too long

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14 Roberts, B., op. cit., p.13.

15 Mabogunje, A.L., op. cit., p.49.

the concept of 'development' has inculcated a dangerous bias in the conceptual approach of academics and politicians alike.

In all the definitions of 'development' by Mabogunje there has remained a thread of the old economic definition: that development, to a greater or lesser extent, implies increased productivity, higher levels of consumption per capita and a shift from primary to secondary and tertiary economic activities. 'Development' is normally equated simply with economic growth. Few studies attempt to grasp the more complex question of social change. The concentration of attention on economic 'development' is no doubt partly due to its easier measurement; how indeed is social 'development' to be measured? In addition to the attention paid to economic issues, there lies the implicit assumption that, in general, development should take place along the lines of Western countries. The use of the word 'development' tends to imply that there is a set of developed nations, normally identified with the Western nations astride the north Atlantic ocean, and a set of less developed, or under-developed or developing, countries which, given the right set of conditions, will in their turn be able to become developed. This, for example, is the implicit assumption behind Rostow's[16] (1978) sequence of stages of economic growth. Even the concept of underdevelopment, which introduces the idea that the poorer countries of the world are poor in some way because of the existence of rich ones and thus overcomes the problems associated with sequential concept of growth and maintains an underlying concern with economic issues. Historically, economic change has always been associated, sooner or later, with the degree of social change. With much recent research having been on economic change, there is perhaps now a need to re-evaluate the social impact of the economic change and, for those involved in implementing it, to redress the balance by planning for social rather than economic change. The experience of the green revolution in India, a classic example of economic growth, was nevertheless associated with increased social inequality (Pearse, 1980)[17] and today remains a pertinent reminder of the need for an integrated approach to change. Similarly, Saudi Arabia's economic transformation is taking place in association with strict efforts to

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16 Rostow, W.W., The World Economy: History and Prospect, Macmillan, London, 1978.

17 Pearse, A., Seeds of Plenty, Seeds of Want: Social and Economic Implications of the Green Revolution, Clarendon Press, Oxford, 1980.

maintain the traditional social and religious structures unchanged. This separation of permitted economic change and forbidden social change is already leading to growing tensions within the kingdom and must remain a source for concern.

During the last two decades 'development studies' have become a far more interdisciplinary field of enquiry. Geographical approaches within this field have much to offer. Gould[18] (1982) thus argues that "in the area of rural-urban interaction geographers have, in the theories and techniques at their disposal and in their appreciation of the needs for detailed data collection, a comparative advantage over other disciplines". Likewise Mabogunje, in conceptualizing development as spatial recognization, has continually emphasized the importance of a geographical awareness in 'development'. Harriss and Harriss[19] (1979) have, nevertheless, noted that there is a "dearth of studies exploring the connections between development and the imperatives of management of the biosphere".

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18 Gould, W.T.S., Rural-Urban Interaction in the Third World, Area, 14, p.334.

19 Harriss, J. and Harriss, B., Development Studies, Prog. Hum. Geog., 3, p.576.

'Development' is thus defined as a process of betterment for a large human group. It includes economic development as well as social transformation. The United Nations University Expert Group on Human and Social Development in November 1975 gave the meaning of 'development' as "Development is fundamentally... about, by and for human beings. Development must therefore begin by identifying human needs. The objective of development is to raise the level of living of the masses of the people and to provide all human beings with the opportunity to develop their potential". Thus the definition clarifies that the development implies not only expansion in quantitative terms but also structural changes in the society and its economy as expansion proceeds. Structural change includes institutional, social and economic (sectoral as well as spatial) aspects. This implicit assumption behind the lumping together of all these aspects is that change in one element depends on and generates changes in all others. Secondly, development means change in a desired direction and at a desired speed. The direction and rates of change will depend upon the goals and objectives of development. Thirdly, development presupposes policy interventions - direct or indirect- in achieving the given goals and objectives. Fourthly, development also involves socio-psychological transformation of human beings to prepare them for the eventual as well as current benefits occuring from the changing socio-economic structure of society; and finally, development involves temporal, sectoral and spatial phasing and integration of planning.

THE CONCEPT OF REGIONAL DEVELOPMENT

Regional development has been interpreted as intra-regional development designed to solve the problems of particular regions. The concept has a multidisciplinary approach. The first connotation of regional development is economic in which the difference in growth in terms of volume and structure of production, income, employment is measured to know differences in the levels of development. This procedure is employed both for national as well as sub-national areas.

The concept of regional development may further be viewed in connection with plan, policies and balanced development. The policies of regional development are aimed at reducing the regional disparities existing in a particular region to a minimum and to find out the possible means for developing the region as a whole. Economic planners have viewed regional development problems from sectoral angles, so that regional development has become synonymous with sectoral planning for a sub-national territory with the result that all the weaknesses of central planning have been introduced at the regional level keeping in view the lack of interest in spatial organization and development.

Balanced regional development does not mean equal development of all regions. It simply implies the fullest development of the potentialities of an area according to its capacity so that the benefits of overall economic growth are shared by the inhabitants of all the regions. Balanced regional development does not mean self-sufficiency in each region. Neither does it mean equal level of industrialization nor a uniform economic pattern for each region. This type of development is practically needed for underdeveloped countries like India to minimize backwash effects, to rapidly develop the economy, to develop the economy smoothly, to develop and conserve resources, to maintain political stability, to defend the country, to overcome social evils and to promote and secure larger employment opportunities. To find the success on these points balanced regional development has been an important policy objective in India since the beginning of the planning era. This idea has been mooted as a corrective process to minimize the differences in the degree of economic and social development in the different parts of the country. Such differences are manifest in per capita income, employment pattern, standard of living, household expenditure, extent of saving, rate of capital formation, growth rate in productive sector, education and social progress.

At the micro level (villages and development blocks), the aim of regional development is generally conceived to minimize disparities in the level of development as observed in differential access to resources and differences in the economic structure and social transformation. These differences are generally found in the industrial structure, access to infrastructural facilities and to amenities. The purpose of the researcher is to measure differences in the general level of socio-economic development, to find out differences between small areas and to suggest alternative distribution of facilities and amenities so that observed differences in access to resources are minimized. Furthermore, the researcher has to find out differences in the pace-setting process as development of technology and modernization so that these processes are strengthened in areas lagging behind. This will facilitate the full use of potentialities offered by a region.

MEASUREMENT OF REGIONAL DEVELOPMENT

It has been seen earlier that measurement of levels of development is an essential stage in policy formulation and planning. Measurement is the assignment of numbers to the properties of empirical objects or events in such a way that a one to one correspondence is maintained between the relations among the properties measured and the characteristics of the numbers assigned. Regional development can be, and is conceived of in many ways. Inherent in the very use of the term is some sense of significant variations in the way in which people produce and consume, work, live and play. To record and measure a vast mosaic of variation in the nation as a whole and in its various parts of regions is no simple undertaking and even the most sophisticated statistical tools can hardly do full justice to measure comprehensively all aspects of regional development, as the variables are so vast and diverse in nature and some even escape the limits of quantification. However,a useful starting point is to make a distinction between the variations that would seem to be associated with the volume of economic activities and social progress. The most commonly employed measures - really crude indicators of economic and social welfare—of improvement or decline in the average status of families and individual are the relative levels of per capita income as it is assumed that economic health is invariably followed by social progress. However, recently it has been argued that per capita income or any other measure of economic progress as levels of production and consumption are partial measures of development as these do not necessarily measure variations in the economic structure and least of social health. They touch only tangentially most of the essential elements of development. The analysis of regional development, therefore, poses the problem of measurement. In early seventies there has come up the social indicators' approach. This approach points out that development goes beyond some aggregate measures of levels of consumption and production of goods and services. This approach emphasizes that variables indicating social status should also be included when measuring levels of development. As such, there is no single criterion on which levels of development can be assessed. Therefore, an analysis of regional development proceeds with the selection of suitable indicators which measure not only differences in the economic structure, and production, but also indicate variations in health, education, housing, leisure, social security and a number of other variables. However, their selection depends on the availability of statistics at appropriate units of analysis.

Measurement of Regional Development in India

Recently there have been many studies of regional development in India and in its parts. These are analyses of spatial variations in resource endowment and of sharp contrasts in levels of development in different parts of the country. An attempt has been made to review some of these studies.

The foremost work is being done by Techno-Economic Surveys. These surveys examine the state's physical resources in their aggregate by a rapid technical and economic audit of the resources of the state ana prepare an overall plan for the development of the states in a 10-15 year perspective in relation to desired growth rate of the economy of the state. The main drawback of such studies is the lack of integrated planning of resources of national importance since every state has been treated in isolation.

There are several other studies which have been conducted for specific purposes in which the emphasis is on the area and its problems in contrasts with sectoral studies. The Central Arid Zone Research Institute at Jodhpur has been studying the problem of semi-arid Rajasthan and neighbouring areas. Various experiments and data complied in respect to geomorphology, vegetation and climate provide valuable material for generalization over wide areas.

A regional approach to the study of urban problem is emphasized by the Town and Country Planning Organization. Master plans of large cities provide a wealth of information on the inter-relationship of the city with neighbouring areas.

In 1956, the Planning Commission, at a conference on Regional Survey and Planning (Delhi, 19-20, October, 1956) recognized that it would be necessary to conceive planning regions for the country at three levels: macro, meso and micro. Since then considerable work has been done and much thought has been given to 'planning region' by the geographers. Studies made by Learmonth, (1964), Prakasha Rao (1962) and Bhat (1962) laid the groundwork for further studies. In 1962, the Regional Survey Unit prepared a tentative regional framework for resource development,[20] for the country based on an analysis and synthesis of various distribution pattern of resources - physical complexes, cropping patterns and the distribution of urban centres, natural resources and major industries. In this study major regions and sub-regions were identified and their characteristics and regional norms of development were described in quantitative terms. The guiding principle in this scheme was that major region should have minimum disparities within their boundaries and maximum distinctiveness from their neighbours in respect of their character and resources for development. Further, Bhat[21] (1964) suggested a scheme of seven macro economic regions based on the distribution of resources and the possibilities of developing regional production complexes. He also considered another set of five macro-economic regions derived by grouping states together.[22]

Based on the work done by Indian Statistical Institute and the earlier census regions, Nath prepared

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20 Rao, V.L.S.P. and Bhat, L.S., A Regional Framework for Resource Development in India, Bombay Geographical Magazine, Vol.10, No.1, 1963, pp.35-50.

21 Bhat, L.S., Aspects of Regional Planning in India, Liverpool Essays in Geography, London, 1964.

22 Idem, Regional Concepts and Planning Regions with Special Reference to Planning in India, in Regional Planning (ed.), R.P. Misra, Mysore, University of Mysore, 1969, pp.73-86.

a scheme of resource development regions and divisions, which was published by Planning Commission in 1964.[23] In this scheme regions were demarcated on the basis of topography, geological formations, soils, rainfall, agricultural landuse, cropping pattern, population density and occurence of mineral resources. The map prepared by Bhat[24] indicates the pattern of industrial development in the background of resource potential in different areas. Contiguous areas of urban-industrial development occuring along the edge of the Krishna - Godavari Delta or from the Coimbatore plateau to the Kerala coast are the resultants of a relatively developed agricultural based industries. The patterns of levels of development as brought out by mapping the index values seems to explain the causes in disparities in levels of development in an objective way. The study shows that the areas having low levels of development coincided roughly with those having low land productivity or lack of good resource base and occurrence of small and stagnant towns without much industrial activity and inter-town relationship. On the

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23 Planning Commission, Government of India, Resource Development Regions and Divisions of India, New Delhi, 1964.

24 Spate, O.H.K. and Learmonth, A.T.A., India and Pakistan, London, 1967, pp.331-364.

other hand, Hyderabad occurs as an 'island' of development in the relatively underdeveloped area of Telengana. Influence of Five Year Plans on the development have been analysed at some length by Learmonth with special reference to Mysore State.[25]

The earliest study in the level of development was made by Schwartzberg[26] (1962). The use of a composite index of development brought out areal differences in levels of development, although these differences could not be further put to rigorous regional analysis as the data were on the basis of states (prior to 1956), which are not ideally suited to reveal regional differences.

Pal[27] (1965) put a more systematic attempt in the construction of a composite index of selected variables which permit several stages of analysis in relation to the group of variables contributing to overall development;

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25 Learmonth, A.T.A., Retrospect on Project in Applied Geography in Mysore State, India, in R.W. Steel and R.M. Prothero (eds.), Geographers and the Tropics - Liverpool Essays, Liverpool, 1964, pp.323-348.

26 Schwartzberg, J.E., Three Approaches to the Mapping of Economic Development in India, Annals of the Association of American Geographers, Vol.52, 1962, pp.455-468.

27 Pal, M.N., Regional Disparities in the Level of Development in India, Fifth Econometric Conference, New Delhi, 1965.

with a study of All India Level it may be regarded essentially as a contribution to methodology in areal differentiation by factor analysis. To be of use in policy decisions these studies need some of the important variables like per capita income and production which are directly related to the levels of development. Using a somewhat different method Mitra[28] (1965) has grouped 324 districts of India into four levels of development. For this study he selected 63 variables and these were grouped into six convenient blocks. The variables pertains to natural factors, agricultural infrastructure, traditional economy, human resources, organized industry, etc. This study is unique for its simplicity and systematic approach. Nevertheless, the author himself pointed out in his introductory remarks that, the lack of more important indices and methods of giving weights to different variables is a limitation to this study. The data of per capita income is difficult to calculate below the state level. The National Council of Applied Economic Research has arrived at district level per capita income and the proportion of 'income' of each district

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28 Mitra, A., Levels of Regional Development in India, Census of India, 1961, Vol.I, Part I-A (i), 1965.

according to primary, secondary and tertiary activities. These data, though crude, serve to relate the income pattern with land use structure and occupational patterns and urban-industrial development in broad regional analysis.[29]

Sen Gupta and Sadasyuk have worked out the economic regionalization of India in an attempt to provide a hierarchy of regions useful in national planning.[30] A scheme of planning regions has been started in the National Atlas Organization. The Planning Commission itself has brought out yet another scheme of 'Resource Development Regions and Divisions of India'.[31]

Nath[32] (1970) on the basis of state and district level data worked out the regional patterns of economic development and economic growth within India. Analysis

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29 National Council of Applied Economic Research, The District Income Differentials 1955-56, Occasional Paper, No.6, New Delhi, 1963.

30 Sen Gupta, P. and Sadasyuk, G., Economic Regionalization of India: Problems and Approaches, in A. Mitra (ed.), Census of India, Monograph Series, Vol.I, No.8, New Delhi, 1961.

31 Government of India, Planning Commission, Resource Development Regions and Divisions of India, New Delhi, 1965.

32 Nath, V., Levels of Economic Development and Rates of Economic Growth in India - A Regional Analysis, The National Geographical Journal of India, Vol.15, Part 3-4, 1970, pp.183-198.

of the level of economic development has been made for both states and districts, but analysis of growth rates has been made only for states. The level of economic development of states has been measured in two ways: (i) on the basis of per capita income, and (ii) through the use of a composite index of economic development based on four indicators. Analysis of economic growth has been made with the help of data on growth rates of population, agricultural output, per capita value added in industry, and per capita income. He mapped the states of India into two categories of relatively developed and less developed.

Prakash[33] (1977) assessed the regional inequalities and economic development in relation to infrastructural facilities in India. He selected several infrastructural factors: the various population characteristics that reflect the development of infrastructure; the determinants of industrialization; the development of power, irrigation and agricultural implements; and road transportation, communication and banking services.

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33 Prakash, S., Regional Inequalities and Economic Development with Special Reference to Infrastructural Facilities in India, Indian Journal of Regional Science, Vol.IX, No.2, 1977, pp.172-195.

He obtained two important conclusions from the analysis of development of individual regions in various fields:

(i) There is no region which is equally developed or under-developed in all the fields. For example, developed areas like Tamil Nadu, West Bengal, Andhra Pradesh, Maharashtra, Kerala and Punjab are under-developed in one or most of the fields like literacy, work-force participation rates, per capita power consumption, irrigation or mechanization of agriculture while the under-developed regions like Jammu and Kashmir, Nagaland, Arunachal Pradesh, Mizoram, Rajasthan, Bihar and Madhya Pradesh are quite developed in one or more fields like literacy, density of population, work-force participation rates, urbanization, power consumption and road transportation. It would, therefore, be more useful for policy purposes to identify individual areas of deficiency rather than to bracket regions as developed or under-developed in general so that the remedial measures to make up the deficiencies could be evolved and implemented;

(ii) The other important result is that the same region/ regions come under the category of developed regions if one indicator is used while they fall in the category of underdeveloped regions if some other indicator relating to the same field is used for classification.

It implies that an appropriate indicator should be chosen to determine the stage of development of the regions.

Hemlata Rao[34] (1984) while studying the regional disparities, dimensions and typology of backwardness in Karnataka applied the technique of factor analysis in delineating the regions. The study covers 175 talukas of Karnataka and examines inter-taluka diversities and disparities in the land utilization pattern, cropping pattern, agricultural development, patterns of industrial spread, and industrial development, levels of development of education, health, transport, communication, power, banking and cooperative sectors and over-all development level during the period between 1975-76 and 1979-80. The study concludes that in Karnataka there is not only wide diversity in the natural endowments but also wide disparities in the levels of sectoral and aggregate development. All backward regions are not the same,

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34 Rao, H., Regional Disparities, Dimensions and Typology of Backwardness and Strategy for Development, ICSSR Research Abstracts Quarterly, Vol.13, No.3 and 4, 1984, pp.1-10.

rather they have different dimensions and typology of backwardness. The causes of backwardness also vary from region to region.

These studies of regional patterns of development in India provide a conceptual and methodological framework to extend them to micro level with necessary modifications. The present study employs extensively concepts and methodology developed in these studies to analyse the patterns of regional development in the area under study.

PART II .

THE STUDY AREA

The Sub-Himalayan East region is hemmed in between the Ghaghara on the south and the Nepal <u>tarai</u> on the north, beyond which the dark but majestic Himalayan ranges rise steeply from the plains and the snow line is clearly visible. Its western boundary is formed by Bahraich district, separated, where possible, by various rivers and streams, but more frequently by artificial boundaries. The eastern boundary is formed by the State of Bihar, the dividing line being partly artificial and in part supplied by the Great and Little Gandak rivers. The region includes the districts of Deoria, Gorakhpur, Basti and Gonda of the northern State of Uttar Pradesh.(Fig.1)

The proximity of the Himalayas, relatively heavy rainfall, the swift flowing streams and soil types, and high water table, all combine to make the Sub-Himalayan East a distinct region. It extends between 26°5'N and 27°55'N latitudes and 81°34'E and 84°26'E covering an area of 26,356 km^2. According to 1981 census the region contained a population of 13,704,896 persons giving a density of 520 persons per km^2.

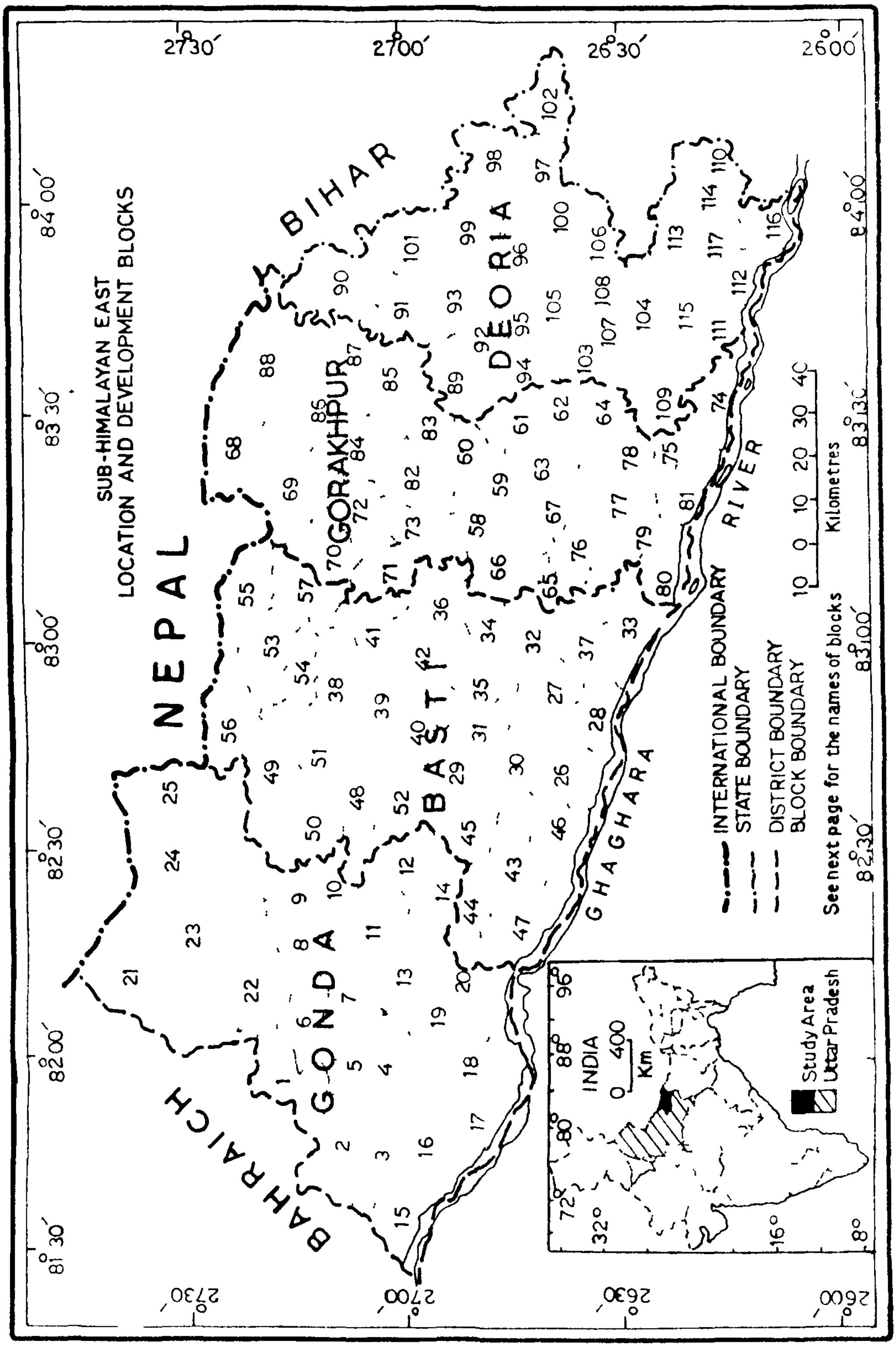
SUB-HIMALAYAN EAST
LOCATION AND DEVELOPMENT BLOCKS
NEPAL
BIHAR
BAHRAICH
GONDA
BASTI
GORAKHPUR
DEORIA
GHAGHARA
RIVER
INTERNATIONAL BOUNDARY
STATE BOUNDARY
DISTRICT BOUNDARY
BLOCK BOUNDARY
See next page for the names of blocks
Kilometres
INDIA
Km
Study Area
Uttar Pradesh

FIG 1

S.No.	Name of the Block	S.No.	Name of the Block	S.No.	Name of the Block
1.	Rupaidih	46.	Captainganj	91.	Nebua Naurangia
2.	Katra Bazar	47.	Bikramjot	92.	Motichak
3.	Haldhar Mau	48.	Domariaganj	93.	Ramkola
4.	Jhanjhari	49.	Itwa	94.	Sukrauli
5.	Pandari Kirpal	50.	Bhanwapur	95.	Hata
6.	Itiathok	51.	Khuniaon	96.	Kasia
7.	Mujehana	52.	Ramnagar	97.	Tamkuhi
8.	Shridattaganj	53.	Naugarh	98.	Dudhai
9.	Utraula	54.	Jogia	99.	Padrauna
10.	Gendas Buzurg	55.	Birdpur	100.	Fazilnagar
11.	Rehra Bazar	56.	Barhni	101.	Bishunpura
12.	Babhanjot	57.	Uska	102.	Siwarhi
13.	Mankapur	58.	Jangal Kauria	103.	Gauri Bazar
14.	Chhapia	59.	Chargawan	104.	Deoria
15.	Colonelganj	60.	Bhathat	105.	Desai Deoria
16.	Paraspur	61.	Pipraich	106.	Pathardewa
17.	Belsar	62.	Sardarnagar	107.	Baitalpur
18.	Tarabganj	63.	Khorabar	108.	Rampur Karkhana
19.	Wazirganj	64.	Brahmpur	109.	Rudrapur
20.	Nawabganj	65.	Sahjanwa	110.	Bankata
21.	Haraiya Satgharwa	66.	Pali	111.	Barhaj
22.	Balrampur	67.	Piprauli	112.	Bhagalpur
23.	Tulsipur	68.	Nautanwa	113.	Bhatni
24.	Gainsari	69.	Lakshmipur	114.	Bhatpar
25.	Pachperwa	70.	Brijmanganj	115.	Bhaluani
26.	Bahadurpur	71.	Dhani	116.	Lar
27.	Bankati	72.	Pharenda	117.	Salempur
28.	Kudraha	73.	Compierganj		
29.	Saltauwa	74.	Barhalganj		
30.	Basti	75.	Gagaha		
31.	Saonghat	76.	Khazni		
32.	Khalilabad	77.	Bansgaon		
33.	Hainsar Bazar	78.	Kauri Ram		
34.	Baghauli	79.	Urwa		
35.	Semariawan	80.	Belghat		
36.	Menhdawal	81.	Gola		
37.	Nathnagar	82.	Paniara		
38.	Bansi	83.	Partawal		
39.	Mithwal	84.	Maharajganj		
40.	Rudhauli	85.	Ghughuli		
41.	Khesraha	86.	Mithaura		
42.	Santha	87.	Siswa		
43.	Harraiya	88.	Nichlaul		
44.	Parasrampur	89.	Captainganj		
45.	Gaur	90.	Khadda		

CHAPTER IV

STRUCTURE AND RELIEF, DRAINAGE, AND PHYSICAL DIVISIONS

STRUCTURE AND RELIEF

The Sub-Himalayan East region constitutes the humid part of the Ganga Plain, which lies between the stable southern peninsula and the recently built Himalayan chain. The plain is 400 km wide in its broadest part, and is about 2,400 km long. It is estimated to cover an area of about 6,40,000 sq. km.[1] . The plain belongs to the recent period of the earth's geological history and has been formed by the detritus and alluvium brought by the Himalayan rivers in the north and the rivers of the Peninsula in the south. The deposition of this alluvium commenced after the final upheaval of the mountains and has continued all through the Pleistocene upto the Recent.

The geological evolution of the Ganga Plain is a matter of discussion. Eduard Suess, an Austrian geologist considered that the plain was a 'fore-deep' between the Himalayas in the north and the Peninsular

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1 Krishnan, M.S., Geology of India and Burma, Madras, 1960, p.573.

India in the south. It was gradually filled up by the sediments eroded by the Himalayan rivers in the north and Peninsular rivers in the south. According to this belief this depression was a synclinorium, out of which, the plain came into existence.[2]

Burrard, on the basis of physical and geodetic considerations, holds a totally different view. He postulated the origin of this depression similar to that of the Great Rift Valley of Africa and probably of the same age.[3] He considers that the plain occupies a deep rift valley bounded by parallel faults on its two sides, with a maximum down throw of 32 km. The formation of this great crack, 2400 km long and several thousand metres deep, was intimately related to the evolution of the Himalayan chain and was in fact the prime event in the whole series of physico-geographical changes that took place at this period in the earth's history. This hypothesis has got a few geological facts in its support. The geologists consider that the depression is only of moderate depth, and that its conversion into the flat plains is due to the

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2 Wadia, D.N., Geology of India, London, 1949, p.282.

3 Burrard, S.S., On the Origin of the Himalayan Mountains, Geological Survey of India, Professional Paper No.12, Calcutta, 1912, p.11.

process of alluviation. The rivers rising from the mountains during a period of great gradational activity, deposited the detritus brought down by them in their long journey and in this way the plains were formed.[4]

A third and more recent view regards this region as a 'sag' in the crust formed between the northward drifting Indian continent in the south and the comparatively soft sediments accumulated in the Tethyan sea as well as in the connected basins in the north. As the sediments in the Tethyan sea was being crumpled up and lifted up into a mountain system, the rivers were filling up this 'sag' and finally the plain came into existence.

However, the major fact that emerges from this discussion is that the depression, perhaps, began to form in the upper Eocene and attained its greatest development during the third Himalayan upheaval in Middle Miocene. Since then it has been gradually filled up by sediments to form a level plain with a very gentle seaward slope.[6]

A limited knowledge is available about the nature of the rocks that underlie the alluvium and the Tertiary

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4 Wadia, D.N., op. cit., 1949, p.283.
5 Krishnan, M.S., op. cit., 1968, p.511.
6 Krishnan, M.S., op. cit., 1960, p.573.

strata of the Ganga Plain. The characteristic features of the Gondwana rocks found on the northern rim of alluvial tract, leads us to believe that its substratum is an extension of the Peninsular rocks, viz., Archaean gneiss with areas of Vindhyan sediments.[7] Wadia and Auden consider that the continuous loading of this trough with detritus since the first upheaval of the mountains, may have accentuated the sinking of the Archaean floor, but as the process of sedimentation kept pace with that of depression, these rose the great plain of India.[8]

There are different opinions regarding the thickness of the alluvium deposits. The Geodetic data obtained by the survey of India Bihar show that the thickness of the deposits in the basins may be of the order of 1800 metres and probably less than 3000 metres. An aeromagnetic survey of the Gangetic delta in Bengal indicates that the basement rocks lie at a depth of about 5181 metres to 6096 metres.[9] The deepest bore hole at

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7 Hyden, H.H., Notes on the Relationship of Himalaya to the Indo-Gangetic Plain and the Indian Peninsula, Records of the Geological Survey of India, Calcutta, 1918, p.274.

8 Wadia, D.N. and Auden, J.B., Geology and Structure of Northern India, Memoirs of the Geological Survey of India, Vol.73, Delhi, 1939, p.134.

9 Krishnan, M.S., op. cit., 1960, p.574.

Lucknow in Uttar Pradesh, is 407 metres and has not yet touched the rock bottom.[10] On the basis of geodetic data, Oldham proves that the Gangetic trough reaches a depth of 457 to 6096 metres towards its northern edge and that its floor has a fairly regular upward slope to the southern edge.[11] By using the gravity results at different stations in the plain, Glennie calculates the depth of the alluvium as 1981 metres, although this figure conforms with geodetic data, it does not conform with geological facts.[12] Cowie, using the same data, adopted even higher figures and considers the trough to have a thickness of 6096 metres.[13]

The sediments of the Sub-Himalayan East plain consist of sand, silt and clay with occasional gravel beds and lense of peaty organic matter. The alluvium deposits of the region may be classified into two divisions:

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10 Oldham, R.D., The Deep Boring at Lucknow, Records of the Geological Survey of India, Vol.23, p.263.

11 Oldham, R.D., The Structure of the Himalayas and Gangetic Plain, Memoirs of the Geological Survey of India, Vol.42, Part II, Calcutta, 1917, p.82.

12 Wadia, D.N. and Auden, J.B., op. cit., p.135.

13 Cowie, H.M., A Criticism of R.D. Oldham's Paper on the Structure of the Himalayas and of the Gangetic Plain as Elucidated by Geodetic Observations in India, Memoirs of the Geological Survey of India, Professional Paper No.18, Dehra Dun, 1921, p.26.

(i) Bhangar (older alluvium) and (ii) Khadar (newer alluvium). These deposits correspond with two main divisions of quarternary era: the Pleistocene and the Recent. The bhangar land occupies the higher land and is not generally inundated by rivers during the rainy season, whereas the khadar land stretches along the river and is occasionally flooded during the rains. A part of the bhangar land in the area possesses a high proportion of lime and the soil is characterized by its remarkable whiteness. The land is locally known as bhat.

Fig.2 shows the present distribution of bhangar, khadar and bhat. The bhangar land is almost level plain above the flood level of the main rivers and their tributaries. The colour of bhangar is dark and is rich in nodules of impure calcium carbonate locally known as kankar. These are of all shapes and sizes, ranging from small grains to lump of fairly big size. The formation of kankar nodules is due to the segregation of the calcarious material of the alluvial deposits into lump or nodules somewhat like the formation of flint in the limestone. Medlicott considers that the kankar nodules and the calcareous beds have been deposited from water containing solution of carbonates of lime derived from the older rock of various kind or else from fragments of limestone contained in the alluvium. Small patches of

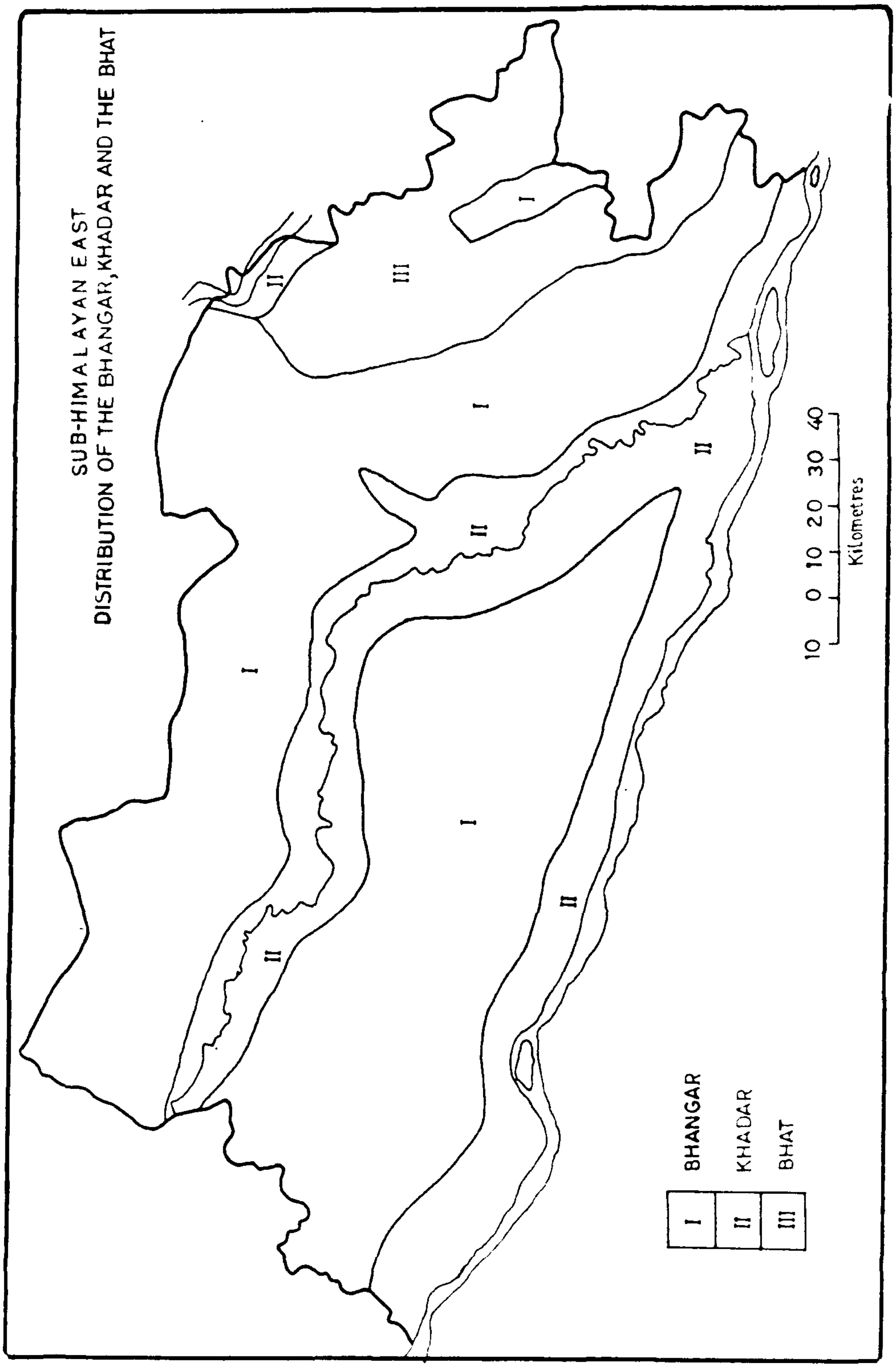
SUB-HIMALAYAN EAST
DISTRIBUTION OF THE BHANGAR, KHADAR AND THE BHAT
I BHANGAR
II KHADAR
III BHAT
10 0 10 20 30 40
Kilometres

FIG 2

saline and alkaline efflorescence are found in bhangar land. During the period of rains, the water, percolating downward, dissolves the soluble salts which have been accumulated in the sub-soil by percolation and by capillary action they are brought back to the surface during the summer months, where they form a white efflorescent crust. Alkaline formations are explained by the fact that the dominant constituent of the old alluvium is clay and sodium clay, which reacting with kankar nodules, is turned into calcium clay and liberates sodium carbonate.[14]

The khadar land is confined to the flood plain of the rivers and is liable to inundation during floods. The khadar is light in colour and is poor in calcareous matter and corresponds in age with upper Pleistocene and Recent. The khadar land occupies a belt of varying width along the various rivers of the area. The khadar of the Ghaghara and the Great Gandak differs from that of the Rapti and its tributaries in the nature of deposits: the deposits of the former are predominantly sandy and sandy loam while that of the latter consist of silt clay. The surface feature of the khadar along the course of Ghaghara and Rapti is marked with irregular depressions which have come into existence owing to the changing course of the rivers. Very often the high floods in

14 Auden, J.B. and Roy, P.C., Report on the Sodium Salt in Reh in the U.P., Records of the Geological Survey of India, Professional Paper No.1, Calcutta, 1942, p.3.

Ghaghara leave coarse sand deposits which are not useful for agricultural purposes. But the floods in the Rapti generally prove useful to the cultivators in the lowlands, even if they destroy the standing kharif crops, because the floods deposit a layer of fertile silt which increases the production substantially and thus compensates the loss of kharif crops and also increases the yield in the successive years.

The bhat land is confined to the eastern part of the Sub-Himalayan East Plain, almost to the east of the river Little Gandak. Occupying the low level lands, bhat usually consists of relatively old alluvium with high amount of calcareous matter and lime, and thus attains a unique characteristic. It is only for this reason it is not considered with either bhangar or khadar and is treated separately. The bhat lands are highly retentive of moisture. The friable nature of bhat, one of its main characteristics, is perhaps due to the high lime contents and also owing to the presence of coarse sandy materials in its upper surface. Bhat is highly calcareous being very rich in kankar nodules of calcium carbonate - responsible for the alkaline reaction by which a high moisture retaining capacity is ensured if it is finely precipitated.

The Sub-Himalayan Plain is a flat region gently sloping from northwest to southeast. This trend of the slope is upto the district boundary between Basti and Gorakhpur. Following the course of the river Rapti, this part of the region has an average slope of one metre per 4 km. In the eastern part of the region the general slope is from north to south following the direction of the rivers. In this part the average slope is one metre per 5 km. The higher elevation occur at places where the general flat surface is broken by irregular ranges of sand-hills.

Another salient feature of the relief is the broad and low valleys of rivers Ghaghara and Rapti, locally called Kachhar or Khadar as opposed to upland country of bhangar. The transition between the two is, in most cases clearly marked since the valleys are well depressed below the general level of the region and are apt to be inundated for a long period during the years of heavy rainfall.

DRAINAGE

The drainage of the entire Sub-Himalayan East region ultimately discharges itself into the Ghaghara, except that of the Great Gandak, which falls into the Ganga a considerable distance below the Ganga Ghaghara confluence. All rivers and their tributaries take a southeasterly direction, following the general slope of the country. The hill torrents, in the northern extremity of the region, follow a southerly direction. There are two main internal sub-divisions: Rapti system in the west and Great and Little Gandak in the east. The principal rivers are the Ghaghara, the Rapti, the Great Gandak, the Little Gandak, the Burhi Rapti, the Kuwana, the Ami and the Sarju, which have a tortuous course forming meanders and ox-bow lakes across the plain (Fig.3). The Ghaghara, the Great Gandak, the Little Gandak, the Rapti and the Sarju have their perennial sources in the Himalayas, whereas other rivers are seasonal in character and have their sources in important ox-bow lakes and perennial *tals*.[15]

The small drainage channels function as a growing organism by increasing in number whenever their occurs a flat lowland for the accumulation of rainwater. The excessive monsoon rains on the southern slope of the Himalaya in Nepal cause multiple small streams which emerge and flow on the gently sloping plain of this region. These minor streams are in most cases seasonal torrents

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15 *Tal* is a local term given to the lakes which owe their origin to the fluvial action.

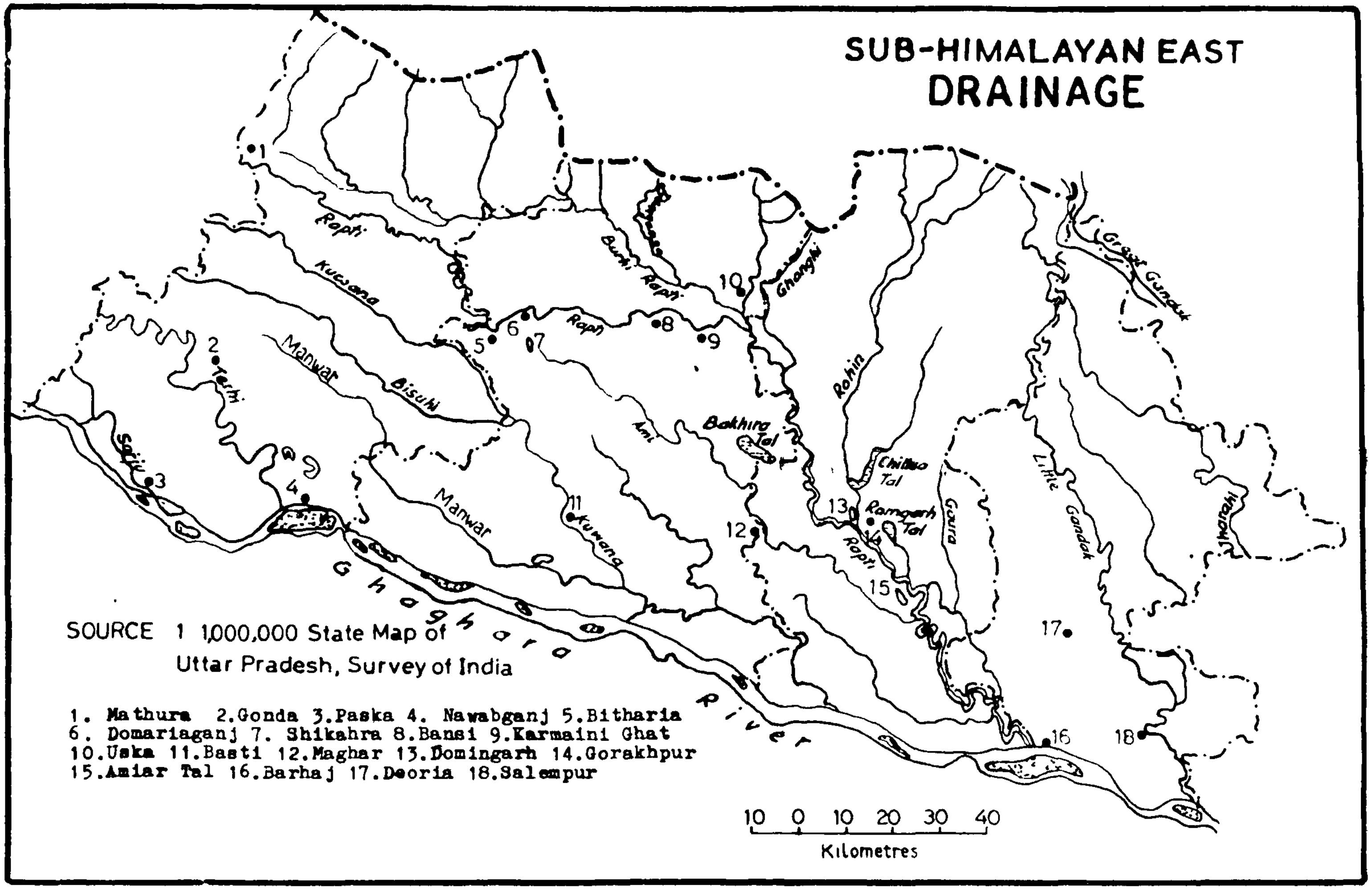
SUB-HIMALAYAN EAST
DRAINAGE
SOURCE 1 1,000,000 State Map of
Uttar Pradesh, Survey of India
1. Mathura 2.Gonda 3.Paska 4. Nawabganj 5.Bitharia
6. Domariaganj 7. Shikahra 8.Bansi 9.Karmaini Ghat
10.Uska 11.Basti 12.Maghar 13.Domingarh 14.Gorakhpur
15.Amiar Tal 16.Barhaj 17.Deoria 18.Salempur
Rapti
Kuwana
Manwar
Bisuhi
Burhi Rapti
Ghanghi
Rohin
Ami
Bakhira Tal
Chillua Tal
Ramgarh Tal
Gaura
Little Gandak
Great Gandak
Jharahi
Kuwana
Manwar
Ghaghara River
Sarju
Terhi
10 0 10 20 30 40
Kilometres

FIG 3

which swell to such a size as to discharge several thousand cubic metres per second but they shrink into a series of disconnected pools and marshes in the hot weather season or dry up completely. The geography of this region is more of hydrography than topography. Water is the keynote in its time and space relationship everywhere it reigns supreme. Surface water in marshes, lakes, tals and sluggish streams and underground water in copious springs and high water table give it a veritable character of a half 'solid' and a half 'liquid' passive surface which raises an obstacle of pure intertia to human movements.[16] The defective drainage system is perhaps, the most important characteristic which is caused by the rivers themselves. The streams are marked by their meandering courses, and branch off in several channels with sluggish movements. The young streams coming down from the hilly region find their gradient abruptly reduced in the plain and deposit their loads in their upper reaches just to form alluvial fans. With the high velocity of the water in their upper courses and poor tenacity of the soil in the plains, the banks do not withstand the force of the

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16 Singh, L.R., The Tarai Region of U.P., Allahabad, 1965, pp.6-7.

flow, nor is the excessive water during the rains accommodated in the channels themselves. Consequently, with the erosion of the banks and silting up of the river-beds, the streams generally over-flow their banks and cut out new channels, sometimes transferring the whole village from one bank to the other.

The major rivers of the plain flow in winding and sluggish courses, forming several meanders and ox-bow lakes and sometimes leaving their former courses completely to adopt new courses. The principal rivers which play a very significant role in making up this region and influence the agricultural economy of the area are described below.

The Ghaghara

The Ghaghara,[17] is formed by the combined waters of the Kauriala, Girwa, Chauka and other streams, which have their origin in the mountains of Kumaun and Nepal. The river forms the southern boundary of the region and is joined by numerous tributaries on its north bank. As it leaves the district of Bahraich, it is joined by the

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17 River Ghaghara was formerly known as Gogra which is a corrupted word of Ghaghara meaning rottling or laughing.

Sarju. Flowing in a more easterly direction the Ghaghara is joined by the Terhi river in Nawabganj block of Gonda district, and further southeast by Kuwana in the district of Basti. It then flows in a continually shifting channels within a broad bed about 6 km in width.[18] Flowing in the same direction it is further joined by the river Rapti and finally it joins the river Ganga at Chapra.

The river has carved a deep and wide bed within which it swings from side to side, varying its channel almost every year among the shifting sandy banks. During the rains it carries an immense volume of water, but in the dry season it shrinks to comparatively small dimensions, and numerous sand banks appear in all parts of the streams, while on either side are to be seen low sandy stretches known as '<u>manjhas</u>'. The manjhas which have received sufficient deposits of silt are cultivated.

The river has a constant tendency to change its course during the annual floods, and in this manner large tracts of land from time to time are transferred either to the northern or southern banks, rending the area of the districts subject to incessant variation. These

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18 <u>District Gazetteers</u>, Basti, Vol.32, Allahabad, 1926, p.9.

changes have occasionally been accompanied by the formation of large islands, and as the deep stream rule prevails, the constant shifting of the jurisdiction of such lands from one district to another results in considerable inconvenience. For instance in 1901, the Ghaghara split up into three minor channels in addition to a main channel, which adopted a course some ten kilometres within the Gorakhpur district. As a result of this encroachment, administrative boundaries were readjusted in 1904 by transferring 107 sq. km of land from the Gorakhpur district to Azamgarh district, so that the Ghaghara once again forms the common boundary between these districts.[19]

The Rapti

The Rapti[20] rises in the outer Himalayas and after traversing the Bahraich district enters in Gonda on the western border of the Balrampur block. It flows thence in a very tortuous course through Balrampur as far as the Utraula boundary, and then reaches the Basti district at Bithariaghat. At that point it bends southwards and forms the district boundary between Gonda and Basti for about 15 km. It again turns east and flows through the

19 District Gazetteers, Azamgarh, Vol.33, 1911, p.28.

20 The river Rapti was originally known as 'Iravati', then corrupted into 'Ravati' and finally Rapti.

blocks of Domariaganj and Bansi in Basti district. Entering into Bansi East, it maintains generally the same direction and leaves the district on the eastern border, a few kilometre south of Uska. After passing through the town of Domariaganj and Bansi, Rapti enters the district of Gorakhpur at Maghar and turns straight southward, forming the common boundary between Basti and Gorakhpur for a few kilometre. It then reassumes its old channel, now known as old Rapti, and flows in a southeasterly course. While passing from the west of Gorakhpur, it is joined by Rohini on its left bank, which though perennial, maintains only sluggish current of water during the dry months. After traversing some distance from Gorakhpur, it is joined by river Ami on its right bank near Amiartal and finally it joins the river Ghaghara near Barhaj.

The river has exceedingly tortuous course being a succession of loops and bends. These loops are especially noticeable to the west of Bansi, and there the tendency of the river to straighten its course, by cutting through the necks of the peninsulas and developing a fresh bend on the other side, has resulted in the formation of ox-bow lakes, generally of a horse shoe shape, and known as 'naukhans', all along its course. The banks are usually high, but the river is continually changing its course. It only overflows its bank in very wet seasons, but then, instead of covering the submerged land with sand, it usually leaves behind a deposit of rich loam.[21]

As far as Bansi, the course of the Rapti in Basti district lies through comparatively high ground and the variation in its channel is small, but east of Bansi the alterations have been very considerable. Formerly it was flowing in the southeast of Bansi and the old bed still exists, but only contains water during the rains, except for a few kilometre above Karmaini Ghat, where the current is very moderate. At other times the Rapti has assumed a more northerly course, as is evident from the very name of the Burhi Rapti (Old Rapti).

The Rapti brings down with it an immense quantity of sand and silt. These deposits are highly beneficial as silt makes the land productive. A consequence of this deposit is that the stream in places has gradually raised its bed above the level of the surrounding country so that a heavy flood may easily result in the adoption of a

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21 <u>District Gazetteers</u>, Gonda, Vol.44, Naini Tal, 1905, p.5.

fresh channel. Another consequence of this phenomenon is that the banks of silt prevent any of the local drainage from flowing directly into the river.

The Great Gandak

Great Gandak[22] touches the extreme northeast corner of the region and at present it has little affect on the region though the influence of this river was great in the past when it was at work throughout the district of Deoria. Taking its rise from the snowy ranges of Nepal, it flows through a gorge leaving its hilly course near Tirbeni about 16 km north from its entrance into the region. Great Gandak is probably most dangerous amongst the rivers which flow in the region owing to its swift flow and changing courses. It attains greater width as it enters the region and forms a bulge towards the west for some distance and then flows southeast having most of its course in Bihar state, and joins Ganga near Patna. Gandak is a voluminous river with a water discharge of thousands cubic metres per second during rainy season and of hundred cubic metres per second during the dry months. The river is usually subject to voilent and sudden floods

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22 Great Gandak is also known as Saligarami in Nepal and Naraini in Deoria and Gorakhpur districts.

at the beginning of the wet monsoon season and causes great damage of <u>kharif</u> crops, cattle and houses. Although Gandak feeds Rohini and little Gandak rivers with a large volume of water when it is in spate, it submerges extensive forest lands of Nepal and plains of northeastern Uttar Pradesh and Bihar and creates a great havoc by wiping out village after village that comes in its way. The river has a good deal of fluctuations in its width ranging from two to three kilometres during the wet monsoon months to 200 or 300 metres during dry summer months. The river Great Gandak has played a very significant role in making up the eastern half of the Sub-Himalayan East plain by depositing it with a very fertile detritus locally known as bhat.[1] The bhat soil is agriculturally very famous as the amount of humus, nitrogen and lime contents is comparatively high in it and above all it has high water-holding capacity and good tilth condition. Consequently the crops in any season need little irrigation and the cost of farming is low, while the yield of such suitable crops as sugarcane, rice and wheat is higher in comparison to the crops in other type of soils. Great Gandak is a navigable river in the northern parts of the plain and a good deal of timber is transported.

The Little Gandak

Little Gandak is an old course of Great Gandak. Great Gandak once flowing through the centre of Deoria district shifted its course to extreme north and then flowed in an easterly direction in Bihar state. The old bed of Great Gandak is famous by the name of little or Chhoti Gandak, which after having flowed some distance in Nepal, enters the region from the northeastern part in Nichlaul block of Gorakhpur district. The river divides itself into two channels after about 2 km below its entrance in the region. One of them flows to the southwest as an insignificant stream and the other which is the main river runs almost south and forms the district boundary between Gorakhpur and Deoria for about 30 km. Thence it takes a southeasterly course and passing through the blocks of Hata, Deoria and Salempur, it joins the river Ghaghara on the extreme southeast corner of Deoria district.

Little Gandak though flowing in a long winding course is not so important as regards its width, volume and velocity of water. For the greater part of the year the river remains in its bed which seldom exceeds 20 metres at any place. During the rainy season, however, it swells considerably and the rate of water-flow exceeds hundreds of cubic metres per second. At this time it overflows its bank and ruins nearby settlements and sweeps away the standing kharif crops. But the effect of this river remains only for a few days because it shrinks very quickly to its bed and looks like a small, sluggish stream.

Flowing in a very tortuous course, the Little Gandak has cut across meanders and loops and formed many ox-bow lakes. The velocity of the river is checked by these loops and bends and erosional capacity is minimised. It has a considerable depth to assimilate the extra volume of water which has usually been reinforced by the spills from Great Gandak and other hill torrents of Nepal. Once this river was navigable to a great distance but gradually its bed has been raised due to the vertical deposition of silt which rendered the navigation difficult. Only small transportation facilities are available where the river has deep beds specially in its northern part.

The Kuwana

The Kuwana, known as 'Kuano', rises in the low ground in the east of the Bahraich district and after a course of some 15 km enters Gonda district at the extreme northwestern corner of Rupaidih block. Then it flows eastward parallel to Rapti upto the district border of Gonda and Basti, from where it turns southward.

Further down, when it enters in the district of Basti, it is joined by river Bisuhi, which rising in Bahraich district, runs parallel to the course of Kuwana. Bisuhi has a deep bed and seldom causes any damage by inundation.

The Kuwana on its right bank is received by Manwar in Basti district. Manwar rises in the north of Gonda and flows in an easterly direction. The Manwar is a fairly well defined river, attaining considerable dimensions in the rains. In most parts of its course the banks are shelving, and the land on either side is remarkable for its fertility.

The Kuwana finally joins the Ghaghara along the block boundary of Belghat and Gola in Gorakhpur district. The Kuwana has a considerable depth throughout the year and has been reinforced from time to time by the spills from the Ghaghara through numerous channels. In the past, the Kuwana was deep navigable stream and was sometimes adopted as an alternative channel by boats descending the Ghaghara during the rains.

The Terhi

The river Terhi rises in Bahraich district and is fed by the waters of the great Baghel tal. It enters the Gonda district on the extreme west of the block Katra Bazar and flowing in a southeasterly direction joins the Ghaghara, a few kilometre above Nawabganj. The Terhi, as its name implies, has a very winding and irregular course. In lower reaches, its banks are high and sandy, and the land in its neighbourhood is of little use for agricultural purposes. During the rains the river attains a considerable size, but at other times it only carries a small volume of water and is useless for navigation. Chemical analysis of the water of river Terhi shows that it lacks iodine, due to which goitre is wide spread disease all along its course.

The Sarju

The Sarju flows in between Terhi and the Ghaghara. It joins the Ghaghara near Paska in Gonda district. It is an insignificant drainage channel of little importance, but at all times of the year renders communication difficult. When the lowland of Ghaghara is inundated after heavy rains, occasionally it changes its course and causes damage by inundation.

The Burhi Rapti

The Burhi or Old Rapti, is a left bank tributary of the river Rapti. It makes its appearance in Mathura on the western borders of the Gonda district and flows in an easterly direction through the northern parts of the Gonda and Basti districts. The river is joined by the river Rapti at about 11 km east of Bansi in the Basti district. The point of junction is at all times liable to change, depending especially on the action of the Banganga. The Burhi Rapti is received by numerous small streams which descend from the outer ranges of the Himalaya.

Throughout its course, the Burhi Rapti has an eastward flow, but is diverted from time to time by the hill torrents which come rushing into it at right angles. The result is that as the river flows through low ground with a very friable soil, its course is tortuous consisting of a series of abrupt turns, with scarcely a straight course anywhere. All along its course is to be seen in a maze of '<u>naukhans</u>' or old channels, similar to those along the Rapti.

The Ami

The Ami is the chief affluent of the Rapti on its right bank. It rises in block Domariaganj near village Shikahra which lies close to the Rapti and emanates from a <u>tal</u>. In the upper part its course is insignificant but gradually it assumes a well defined channel and flows through a tract of stiff clay. After traversing the central part of the Basti and Gorakhpur district the river discharges into the Amiar tal, which is connected with the river Rapti by a channel of considerable proportion.

The Rohin

The Rohin is the chief affluent of Rapti which has developed its own drainage system of dendritic type. After traversing a long hilly course in Nepal, it enters the Gorakhpur district and flows in a southerly direction upto its confluence with Rapti river near Domingarh on the western extremity of Gorakhpur city.

Rohin is a perennial river with a considerable magnitude of water even in winter season, but for a short time during summer it is reduced to a small current. Throughout its course in the northern tarai part, it has steep banks and sandy beds with occasional deposits of pebbles. The river in this part has comparatively clear water and has developed a well-defined narrow valley. Afterwards it turns to be the usual river of the plain having a raised silty bed and muddy water. Rohin, in its southern part, has developed broad valley and flows in winding and tertuous course leaving behind loops and bends like Rapti. Owing to these bends, the river flows as a sluggish stream, The river has also a tendency to cut aside deep meanders and form ox-bow lakes. The river attains its greater dimension during the rainy season when it is drained by the Great Gandak river in its upper course in Nepal and several other smaller hill torrents.

The river carries down enormous quantity of fine sand and silt each year and deposits them in its valley to make it more fertile, though the loss is considerable when the standing kharif crops are swept away with the flood-water.

Lakes

The entire Sub-Himalayan East region is studded with numberless lakes, many of which are of considerable size and form a valuable addition to the water supply. Due to excessive rainfall during the wet monsoon months numerous lakes come into existence. The important lakes of the region are Bakhira, Ramgarh, Domingarh, Amiar and Chillua.

On the basis of their origin, the lakes may be divided into two groups. The first group includes those lakes which are formed by the fluvial action of the rivers and their changing courses. The rivers of the region generally form loops and bends and change their courses, detaching these bends aside with alluvial deposition on their mouths just to form a lake. These ox-bow lakes resemble like a horse-shoe and are locally known as naukhans. In most cases, these ox-bow lakes are connected with the rivers by small channels, and discharge the excessive rainwater accumulated in them during the wet monsoon months. These lakes play the role of a reservoir for the surface drainage of the neighbouring areas and protect them from the danger of flood as long as the river itself overflows its banks. On the convex and outer side of the lakes, the banks are high but on the inner side they are generally low and are liable to be inundated when the water in the river or the lake rises.

The second group of lakes comprises the natural depressions in which the rainwater accumulates. These depressions are again liable to overflow during the period of heavy rainfall and occupy an extensive area. With a huge sheet of water in rainy months these depressions form lagoons and again shrink to almost dry beds when the rainy season is over. These lakes generally have no connection with the rivers and maintain their individual entity. Sometimes they are found in a series to form an ill-defined drainage line which may be turned into a small stream when the rainfall is abnormally high. The Chillua tal is one such example.

The lakes are widely used for irrigation purposes in the region and are the greatest source of fisheries. Besides, these lakes usually produce water-nuts and provide weed and grasses for animal-food.

PHYSICAL DIVISIONS

Physiographically the whole region of the Sub-Himalayan East represents a level topography with little variations in its structure, relief and drainage. It has a gentle slope towards southeast though the eastern half of the region tends to be sloping towards south. The plain is drained by several perennial and non-perennial rivers which play an important role in the development of the physical landscape. These rivers and their tributaries have formed their valleys which vary greatly in character depending upon the nature of the flow and the depositional or erosional aspects of the rivers. However, on the basis of relief, drainage and structural variations, the region can be divided into four physical divisions:

I. The Tarai

II. The Khadar

III. The Central Plain

IV. The Eastern Bhat Plain

I. The Tarai

The tarai tract extends from west to east along the boundary of Nepal (Fig.4). A clear-cut demarcation line between tarai and other regions may not be easily drawn. Specially its demarcation with the western khadar tract is extremely difficult because the latter has almost all the characteristics of the tarai and on a general physical map, it may easily be put with the tarai. The tarai area of the region is certainly a continuation of the Nepalese tarai belt. The tarai tract extends roughly 15 to 20 km in width from the International boundary between India and Nepal. The southern limit of the area in its western part may be taken roughly the Rapti river excluding only a small fringing area of khadar. In the eastern part of the tarai, the southern limit is only arbitrary and is represented by high water-table and numerous small hilly torrents which loose themselves into a major river by the time they leave the tarai tract. The main characteristics of this belt is the high water-table, marshy land, clayey soil, ill-drainage, frequency

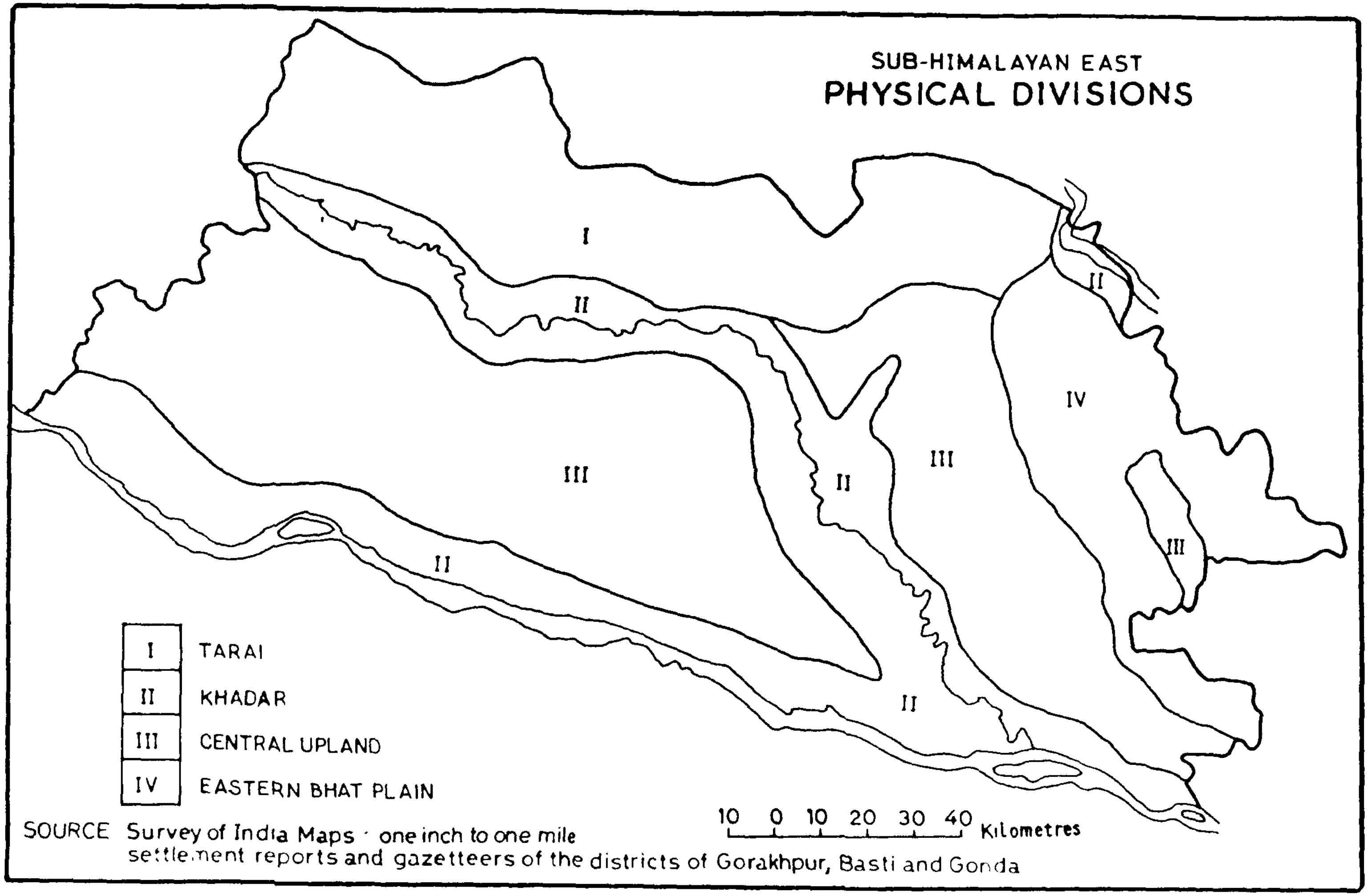
SUB-HIMALAYAN EAST
PHYSICAL DIVISIONS
I
II
III
IV
I TARAI
II KHADAR
III CENTRAL UPLAND
IV EASTERN BHAT PLAIN
10 0 10 20 30 40 Kilometres
SOURCE Survey of India Maps · one inch to one mile
settlement reports and gazetteers of the districts of Gorakhpur, Basti and Gonda

FIG. 4

of forests which are associated with high rainfall. The whole tract is a shallow basin which is frequently flooded during the wet monsoon months when a large number of streams swell considerably to submerge it under water. These swift flowing streams generally bring down an enormous quantity of silt and clay and deposit them in this tract. Consequently the area is turned to be fertile and is specially suitable for the cultivation of transplanted rice.

The tarai tract is comparatively sparsely populated due to extremely unhealthy climate and bad quality of water. The water is generally of oily nature and is deficient in iodine leading to certain diseases like goitre and leprosy. The frequency of marshes and drainage lines, abundant rainfall, high temperature and proximity to the forest, render the region unfavourable for human settlement. The unhealthy climate of the region is favourable for the growth of poisionous mosquitoes and other germs which are sources of such diseases as malaria and philaria. However, in recent times the general condition of the tarai region has been changed. The major areas under forests of the tarai region have been cleared. Only reserved forests are left. The old cultivated and deforested areas are using modern techniques to increase the agricultural production. Besides, institutions are playing vital role in developing the region. The diseases of malaria and philaria have also been minimized through opening of the Primary Health Centres.

II. The Khadar

This region is confined in low-lying belts along the major river banks and is formed mainly by the newer deposits of sand and silt brought down and renewed almost every year, by the rivers Ghaghara, Rapti and Great Gandak. During the wet monsoon months this low-lying belt is either completely submerged under a broad sheet of water or is turned into swamps and shallow lakes. In the cold weather season, the surface of this tract becomes dry except scattered low-lying marshes and small pits. Even in this season the water-table is very high and the water can be found by digging only a meter below the surface. In summer, the water can be found at a depth of about two metres. As a result, almost all the crops in this tract are sown and harvested without irrigation.

The soil of this tract varies from sand along the banks of rivers Ghaghara and Great Gandak to silt along the banks of river Rapti and Rohin with occasional deposition of clay in depressions. The silty deposits of the Rapti Valley is comparatively much fertile and productive while the deposits of the Ghaghara and Great Gandak are coarse sand and are generally less productive. The moisture retaining capacity in the silty khadar of Rapti is far greater than that of the khadar of Ghaghara and Great Gandak rivers.

The soils of this tract is less productive when compared to those of the bhangar lands. They are lighter in colour appearing ash-grey on the surface because of the higher amount of sand present in the soil. During the rainy season the salt is dissolved and percolates in the subsoil, while during the summer months, as a result of capellary action the solution comes on the surface. The water evaporates leaving behind an incrustation of white efflorescence on the surface. The resultant effect is that the land turns to be unproductive. The drainage in this area is also imperfect because of the high water table.

In spite of these drawbacks the alluvial belt is one of the most fertile portions of the region. The fertility of the soil varies inversely with the proximity of the sand to the surface and the degree to which it is mixed with the loam. Throughout the tract irrigation is ample, as water is near the surface, wells are easily constructed, and the numerous tanks, which are filled from the overflow of the rivers in the rains, form natural reservoirs for use in the dry season.

III. The Central Plain

The Central Plain is bounded by the tarai in the north, by the khadar in the south and bhat in the east. This plain is divided into two parts by the khadar tract of the river Rapti (Fig.4). A narrow small strip of the bhangar in Deoria district which is an infiltration to the bhat plain may also be included in this region. Largely confined in the central part of the region, the plain is formed by the older alluvium. It is a level country sloping gently from northwest to southeast.

The central plain lying between the Ghaghara and the Rapti rivers includes the bhangar lands of the districts of Gonda and Basti. It is almost a level plain. It is good fertile tract and is not liable to flood except in the lower Ami Valley in the years of successive rainfall. The monotony of the plain is broken by slight undulations and important drainage channels, or by local depressions. This region varies in character from tarai in the north to Ghaghara Valley in the south. The water level varies from place to place, although the difference is insignificant. In the north it ranges between 6 and 8 metres whereas in the south it varies between 5 and 6 metres. The soil varies from sandy loam in the west to loam and loamy clay in the east. The principal crops of the region are rice,maize, wheat, barley, gram, peas and sugarcane.

Another part of the central plain lying east of the river Rapti is formed by the older alluvium which is stretched over the eastern portion of Gorakhpur and western portion of Deoria districts. It is a level plain sloping gently from northwest to southeast. It stretches on such heights as to be always beyond the reach of high flood-water. Except a narrow strip of sandy ridge in the extreme east of the plain, the whole tract is comprised by extremely fertile loamy soils.

IV. The Eastern Bhat Plain

The northeastern part of the Sub-Himalayan East region is characterised by a low-level plain made by the alluvium of Great Gandak and Little Gandak rivers. The whole tract can easily be distinguished from other parts of the region owing to the prevalent calcareous soil (bhat) which gives it a ash-white look. The western limit of the area may be taken roughly to be the Little Gandak river though a small fringe to its west is also included into this zone where the soil tends to be ash-white(Fig.4). The monotony of the tract is broken by a narrow elongated strip of bhangar land stretching roughly from the towns of Padrauna and Kasia to the south upto the district boundary of Deoria.

The texture of the bhat varies from clayey-loam to sandy loam but the amount of lime in each case is as high as 25 to 27 per cent. The water-table in this tract is very high ranging from one metre during wet monsoon months to about two metres in the dry summer months. The drainage is perfect owing to the presence of large amount of lime which allows the underground water to move freely. The soil of this tract maintains good tilth and in average farming conditions gives better yield. Agriculturally, this tract is one of the most important areas of the region specially for the cultivation of rice and sugarcane.

CHAPTER V

CLIMATE

The Sub-Himalayan East Region experiences a sub-tropical monsoon type of climate which is characterised by a seasonal rhythm produced by the southwest and northeast monsoons. The word monsoon is derived from the Arabic word 'mausim' which signifies 'season'. In its fundamental meaning, based simply on day-to-day experience, the term 'monsoon' designates the seasonal surface air currents, reversed from summer to winter.[1] The reversal of pressure takes place regularly twice a year due to these two prevalent types of winds. During the northeast monsoon period, the wind blows from west to east. It is almost dry because of its origin over the landmass. The weather in this season is marked by clear skies, low humidity and extremes of temperature. During the southwest monsoon months, the winds in this region blow from the east towards west. They are oceanic in origin and are exceedingly laden with moisture. The associated weather is characterised by over-cast skies, heavy

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1 Pedelaborde, P., The Monsoon, Translated by Clegg, M.J., London, 1963, p.4.

rainfall and high relative humidity. In the light of the most salient characteristics of these two types of winds, the appropriate terms of dry monsoon and wet monsoon may be suggested. The pressure gradients during the dry monsoon season are very low and the resultant wind force is also weak. On the other hand, the intense heating of the area during the wet monsoon season gives birth to steep gradients owing to which the wind blows relatively with a high speed.

The seasonal rhythm of monsoon reversal is the chief characteristic of the region -- the slightest variation of which largely controls the agricultural operations of the area. The two farming seasons of kharif and rabi are determined by the wet and dry monsoons. Dry monsoon period extends roughly from November to the middle of June and the temperature variations between the first four months and the last three and a half months are so great that it becomes safe to divide this period into cold weather season which includes the months of November, December, January and February and hot weather season including the months of March, April, May and the first half of June. The cold weather season corresponds with the season of rabi crops but the hot weather season by virtue of its being completely dry never permits agricultural operations. The ripenning of the rabi crops is however, helped by this season. The wet monsoon season includes the remaining months of the year i.e., from mid-June to October and corresponds with the kharif season. Thus, there are three distinct seasons most commonly recognised in the Sub-Himalayan East.[2]

1. The Cold Weather Season (November to February)
2. The Hot Weather Season (March to mid-June)
3. The Season of Rains (Mid-June to October)

<u>THE COLD WEATHER SEASON</u> (November to February)

After the retreat of south-west monsoon, the region comes gradually under a high pressure belt which develops over the plain due to low temperatures. The prevailing wind blows from west to east and its direction is determined by the combined effect of the pressure

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2 Indian Meteorological department has recognised two major climatic seasons with two sub-divisions:

(a) The season of northeast monsoons:
  (i) January and February; The Cold Weather Season
  (ii) March to Mid-June; The Hot Weather Season

(b) The season of southwest monsoons:
  (i) Mid-June to Mid-September - season of general rains
  (ii) Mid-September to December - season of retreating monsoons.

distribution and the lofty ranges of Himalayas. The pressure gradients are not steep enough to produce strong winds. The breezes are light with a velocity of about 3 or 4 km per hour in November and December.

The mean monthly temperatures in Gonda and Gorakhpur in November are 20.9°C and 20.7°C respectively. The mean maximum temperature in November at the respective stations are 28.7°C and 27.8°C respectively while the mean minimum temperatures in the same month for the same stations are 8.7°C and 11.1°C respectively (Fig.5). In December the temperatures further decreases by about 5.0°C and the days become less warm whereas the nights become colder. The month of January records the lowest temperature of the year and, therefore, it is the coldest month. The mean monthly temperature in January is 15.5°C at Gonda and 16.0°C at Gorakhpur. During these months, heavy mist or fog locally known as <u>Kohra</u> often occurs at night and lasts untill the early morning hours.

The month of February registers a slight increase in the temperature but the nights are still cold and the days are comparatively warmer. The mean monthly temperatures at Gonda and Gorakhpur are 18.2°C and 18.3°C respectively (Fig.6).

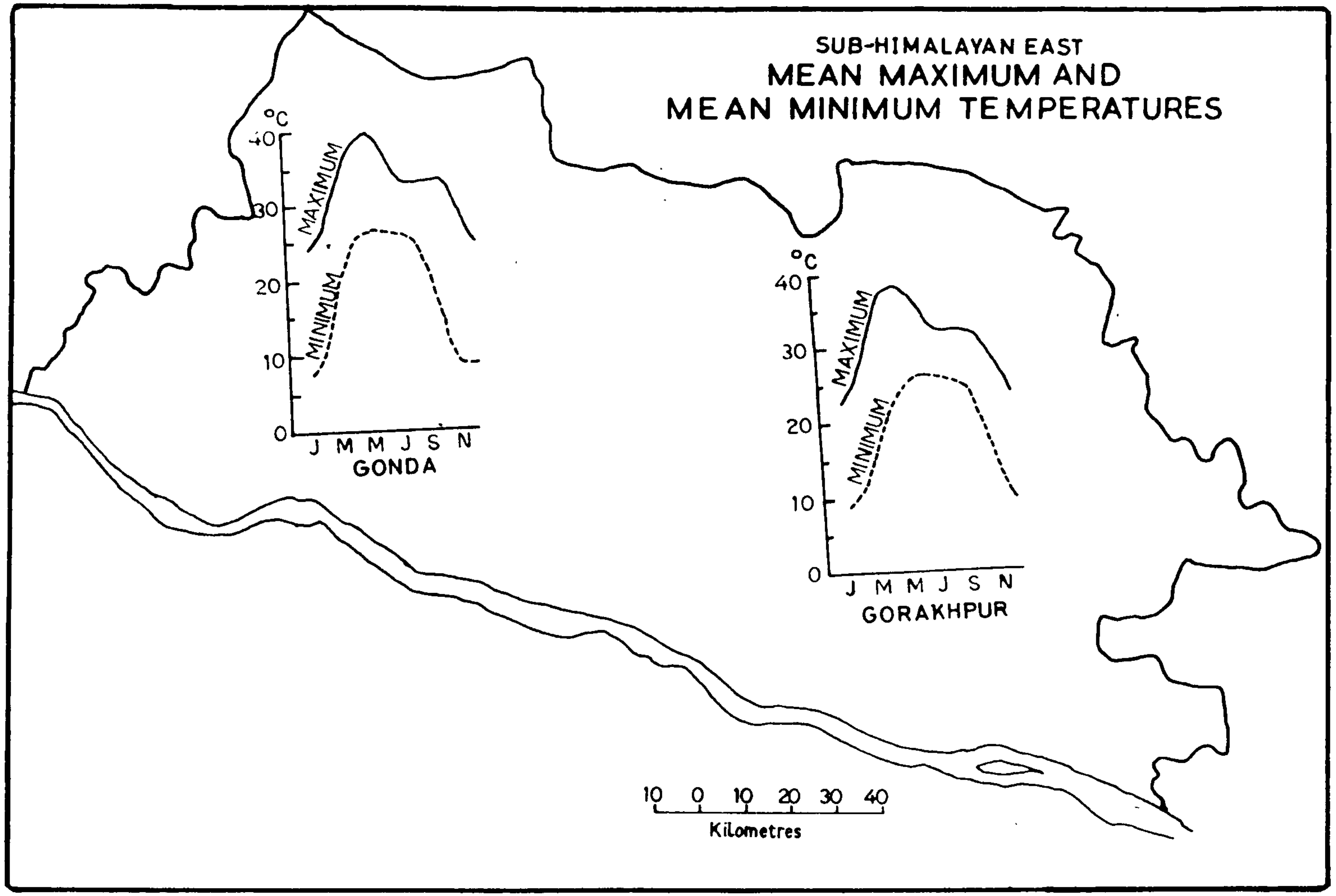
SUB-HIMALAYAN EAST
MEAN MAXIMUM AND
MEAN MINIMUM TEMPERATURES
°C
40
30
20
10
0
MAXIMUM
MINIMUM
J M M J S N
GONDA
°C
40
30
20
10
0
MAXIMUM
MINIMUM
J M M J S N
GORAKHPUR
10 0 10 20 30 40
Kilometres

FIG. 5

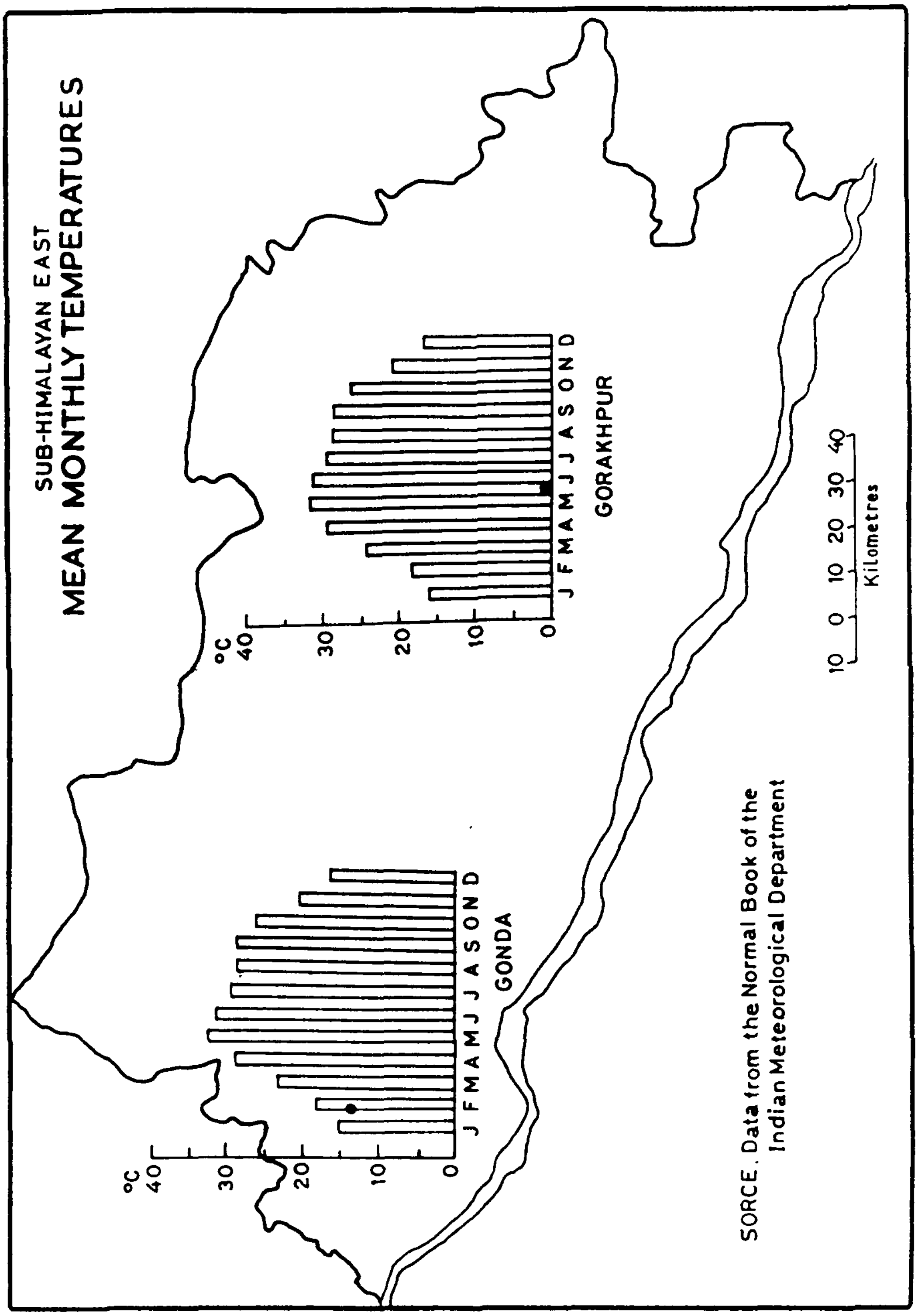
SUB-HIMALAYAN EAST
MEAN MONTHLY TEMPERATURES
°C
40
30
20
10
0
J F M A M J J A S O N D
GONDA
J F M A M J J A S O N D
GORAKHPUR
10 0 10 20 30 40
Kilometres
SORCE. Data from the Normal Book of the Indian Meteorological Department

FIG.6

The influence of tarai and proximity of Himalayas over the climatic condition of the region may well be appreciated by examining the relative humidity of the cold weather season. The relative humidity is sufficiently high, the mean monthly being never below 70 per cent during any of the four months at any station mentioned above. Gorakhpur records an average of 73, 78, 79 and 71 per cent respectively during November, December, January and February.

The rainfall during the cold weather season is small, irregular and sporadic. It is locally heavy where the thunderstorms are associated with disturbances. The average rainfall in January at Gonda, Basti, Gorakhpur and Deoria is 16.2, 14.0, 13.4 and 14.3 mm respectively while in the month of February for the same stations it is 20.8, 19.6, 19.1 and 16.8 mm (Fig.7) respectively which is highest in the cold weather season. The winter rainfall is highly beneficial to the rabi crops. The effectiveness of this rainfall is further increased by the prevailing low temperatures. Amidst the general fine weather, there occur some disturbances brought by the western depressions during the months of December, January and February. The region is benefitted with a small quantity of rainfall when these depressions appear in

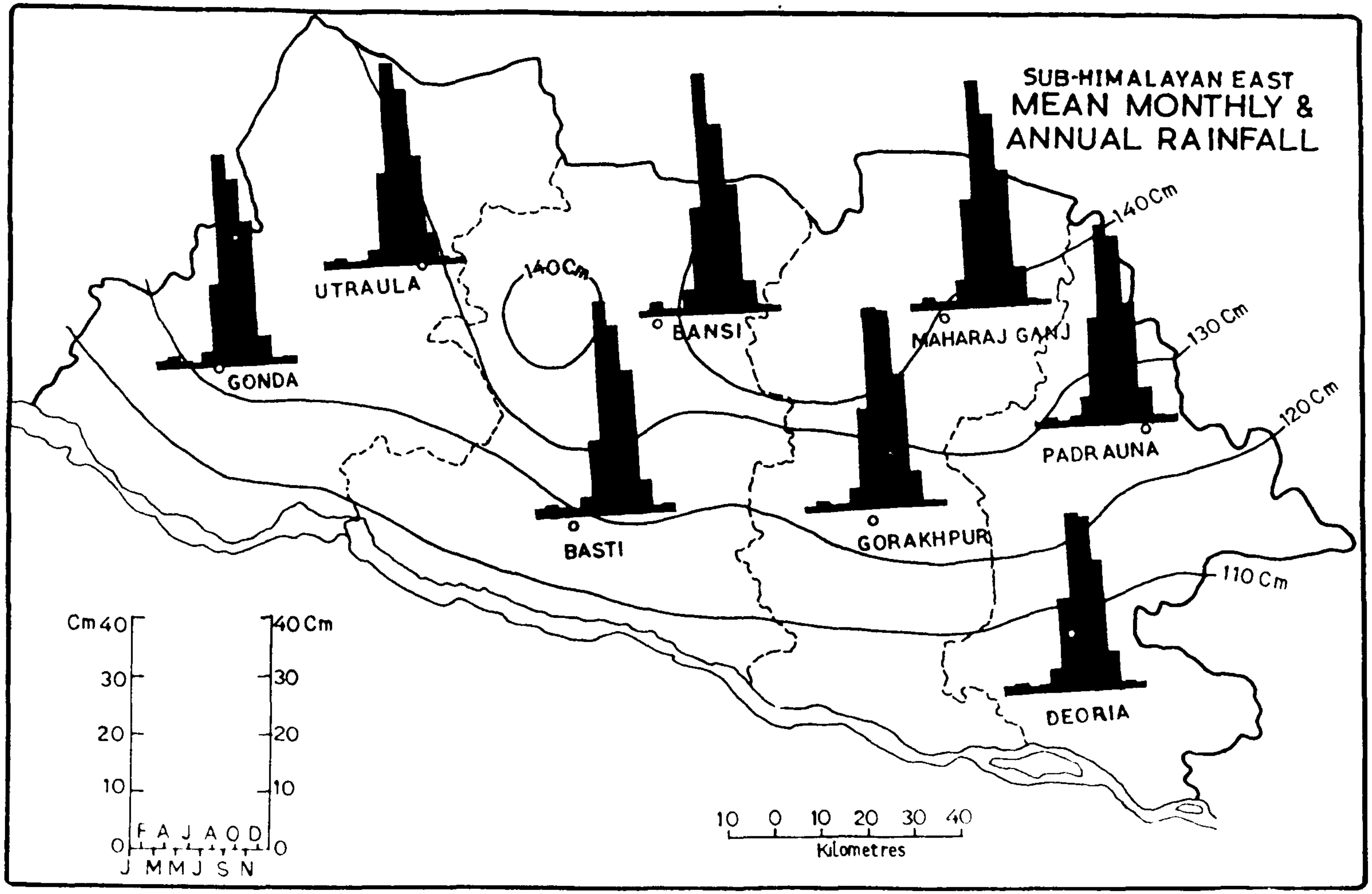
SUB-HIMALAYAN EAST
MEAN MONTHLY & ANNUAL RAINFALL
GONDA
UTRAULA
BASTI
BANSI
GORAKHPUR
MAHARAJ GANJ
PADRAUNA
DEORIA
140 Cm
140 Cm
130 Cm
120 Cm
110 Cm
Cm 40
30
20
10
0
40 Cm
J F M A M J J A S O N D
10 0 10 20 30 40
Kilometres

FIG 7

this season. Some of these depressions originate in the Mediterranean area and a few come from the Atlantic.[3] The rainfall caused by the depression is preceded by a warm close weather with light southerly or easterly winds and is followed by a considerable fall of temperature and strong and cool westerly winds. The cloudy weather is temporary for a day or so and is followed by clear skies. Trewartha[4] considered the course of western depressions which approximate that of the jet stream across northern India. These disturbances reach their maximum development in this season when the jet lies south of the Himalayan mountains. In rare cases the cold weather depressions bring with them hailstorms. These hailstorms are liable to damage the rabi crops heavily if they occur late in January and February when the flowers and immature ears of the plants are bruised by them. In case they occur during November and December, the damage done by them is comparatively low. It is often experienced that the crop in one field may be seriously

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3 Shafi, M., Land Utilization in Eastern Uttar Pradesh, Aligarh, 1960, p.19.

4 Trewartha, G.T., The Earth's Problem Climates, Madison, 1962, p.154.

affected by them while the crops of the next field only a few metres away are totally immune from their adverse effect.

THE HOT WEATHER SEASON (March to Mid-June)

The beginning of March is well marked by a rapid increase of temperature because of the apparent movement of the sun northward. With the increase in temperature, the pressure falls abruptly on the heated plain but the sub-tropical anti-cyclone still persist.[5] In this season the area is dominated by a low pressure system due to high temperature. The mean maximum monthly temperatures in March at Gonda and Gorakhpur are 32.2°C and 31.2°C respectively, while the mean minimum monthly temperatures for the same month of the respective stations are 20.3°C and 16.3°C respectively. The month of May registers the highest temperature of the year. The mean monthly temperatures for this month at Gonda and Gorakhpur are 32.3°C and 31.7°C respectively while the mean maximum temperatures of the respective stations are 39.3°C and 38.4°C respectively. The temperature begins to decrease in June. The mean monthly temperatures

5 Kendrew, W.G., The Climate of the Continents, Oxford, 1961, p.162.

are $31.7^{o}C$ and $31.1^{o}C$ at Gonda and Gorakhpur respectively. The percentage of relative humidity increases to 70 as compared to 40 during May. This increase in humidity coupled with high temperature makes June a month of unbearable heat. The relative humidity in the month of May at Gonda and Gorakhpur is 47 per cent and 58 per cent respectively.

In the summer months hot dry winds locally known as '<u>Loo</u>' are a regular phenomena and their intensity becomes greater in May and June. The most characteristic features of hot winds are their intense dryness and excessive temperature. Their velocity increases in the afternoon and they blow with violent force till 4 p.m. in the evening when their force is retarded to such an extent that they practically disappear from the scene. The humidity on such occasions sometimes falls to as low as 2 per cent from noon to 4 p.m. Such condition persists untill the middle of June prior to the onset of the southwest monsoon.

The occurence of dust storms locally known as '<u>Aandhi</u>' is another phenomenon of this season. These dust storms last for a short time, give peculiar reddish yellow glare to the sunlight, more specially in the afternoon and sometimes bring about a small amount of rainfall. Sometimes these are accompanied by thunderstorms which do a lot of damage to buildings and trees.

The rainfall during this season is sporadic, short lived, subject to great local variations and frequently repeated about the same hours day after day for many days in succession. The month of June receives highest rainfall in this season. The rainfall during this month at Gonda, Basti, Gorakhpur and Deoria are 14.3, 13.0, 16.1 and 15.9 cm (Fig.7). The rainfall of the hot weather season provides a temporary relief from the intensity of the heat and makes the weather pleasant often for a day or a couple of days. After the rainfall, the air becomes cool and the circulation of the dust particles in the atmosphere is reduced to the minimum. The humidity slightly increases for sometime, but again decreases gradually during the dry period when there is no rainfall, and the heat again becomes unbearable.

<u>THE SEASON OF RAINS</u> (Mid-June to October)

The beginning of June is marked by a more severe characteristics of the hot weather season when the heat coupled with dryness of the atmosphere becomes intolerable. At this time an intense low pressure area develops in northwestern India. As a result the zonal westerlies over northwestern India begin to move northward but this is resisted by the mountains. Consequently the jet stream which has been south of the mountains at about 30°N during winter, tends to alternately disappear and then reappear south of the mountains. The disappearance is associated with the northward advance of the summer monsoon. Finally in late May or early June, the jet disappears completely over northern India and takes up a position at about 40°N to the north of the Himalayas. At the same time there occur a westward movement of the low pressure trough from 85°E to 75°E over western India. With the disappearance of jet over northern India and a westward shift of the trough, monsoon winds enter the Plains.[6] These moisture laden winds bring an abrupt change in the weather and a sudden fall in day temperature occurs. The atmosphere becomes cool and pleasant. The mean monthly temperatures in July at Gonda and Gorakhpur drops to 29.6°C and 29.5°C respectively (Fig.6). Relative humidity increases from 50 per cent in May to 80 per cent in July. The sky becomes overcast for days together

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6 Trewartha, G.T., op. cit., p.159.

and rainfalls in downpours, sometimes accompanied by violent thunder and lightening.

The rainy season begins from mid-June and it lingers on to the end of October. The rainfall received in this region is copious because the two main currents of the monsoon i.e., Bay of Bengal current and Arabian Sea current after meeting in Central India reach here with an increasing force. The interruption of the Himalayan chain brings about heavy rainfall in the immediate neighbourhood of the southern Himalayan slopes, a part of which is occupied by the Sub-Himalayan East region. Rainfall begins in June and remains steady with alternating rainless intervals in July and August and decreases in quantity and frequency in the month of September. By the month of July the wet monsoons are fully set in the region. Rainless intervals of a day or two are interspersed frequently during the rainy months. The months of July and August are the rainiest month of the year receiving more than half of the total annual rainfall (Table 1).

Each of the stations, except Gorakhpur, receives more than 54 per cent of total annual rainfall during these two months. The annual rainfall is shown in Fig.7.

Table 1

Distribution of Rainfall
(Rainfall figures are in Centimetres)

Stations	Total Annual Rainfall	Rainfall in July & Aug.	Percentage of the total rainfall
Gonda	125.3	70.7	56
Tarabganj	109.6	62.2	57
Utraula	118.4	67.1	57
Mankapur	99.5	58.3	59
Basti	120.0	66.6	55
Domariaganj	145.9	79.5	54
Bansi	134.0	76.0	57
Harraiya	123.4	71.5	58
Khalilabad	118.6	69.1	60
Gorakhpur	124.8	49.9	40
Maharajganj	136.2	74.1	54
Bansgaon	110.2	65.1	59
Pharenda	184.7	102.0	55
Deoria	105.8	57.6	54
Hata	125.9	69.0	55
Padrauna	125.1	67.8	54

The rainfall normally declines in September and longer intervals prevail; for example, the average number of rainy days at Gorakhpur in July and August are 14.3 and 14.9 respectively which is reduced to 9.3 in September. The mean monthly temperature in this month remains as high as 28.8°C at Gorakhpur and Gonda, but the decrease in temperature which is usually marked in late September results in the increase of the atmospheric pressure and the monsoonal currents begin to weaken. This weakening is, however, a slow process in contrast to the sudden burst with which the monsoon commenced.[7] The day temperature in September is, however, 0.4°C higher than that of August but the mean monthly temperatures during August and September are almost similar. The day temperature in September increases a little perhaps, due to comparatively low cloudy weather. The relative humidity comes down to about 80 per cent and the amount of cloud is only 4.3 in this month. The average rainfall in September at Gonda, Basti, Gorakhpur and Deoria is 21.8, 23.1, 25.1 and 22.2 respectively. The rainfall during the month of September is beneficial to the standing rice crops. The high humidity, low amount of

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7 Kendrew, W.G., op. cit., p.180.

cloud, the long rainless interval, high temperature and calm atmosphere together make the month of September sultry.

In October, the mean maximum temperature decreases to 31.7°C from 32.4°C in September at Gorakhpur. The monsoon completely weakens with the development of a high pressure belt. The remnant of wet monsoon gives only an insignificant amount of rain to the region. The average rainfall in October at Gorakhpur is only 7.54 centimetres and the number of rainy days seldom exceeds three. Relative humidity remains as high as 75 per cent. High temperature coupled with motionless air and sufficiently high relative humidity make the months of September and October very uncomfortable.

The period of the wet monsoon is not one of the continual rainfall because the rain-bearing currents do not appear in the region day after day. The periods of rainfall are interspersed by the spells of fine weather which are very useful for the kharif crops. The spells of fine weather do not last many days and are produced by "a shoulder of the high pressure" which embraces the whole region by pushing the axis of low pressure trough of northern India towards the foothills of the Himalayas.[8] The rainless period with clear sky is most welcome to the farmers because the continued rain with cloudy sky not only damages most of the crops but also interrupt their agricultural activities.

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8 Blanford, H.F., The Rainfall of India, <u>Indian Meteorological Memoirs</u>, Vol.III, 1886-88, p.217.

CHAPTER VI

SOILS

The character of agriculture depends mainly on the nature of the soils. The Sub-Himalayan East region is included into a broad belt of alluvial soil without any further sub-classification[1] The soil map of India and

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1 The soil map of the Geological Survey of India prepared by D.N. Wadia, M.S. Krishnan and Mukerjee, published in the Memoirs of the Geological Survey of India, 1935, Plate XXV; The soil map prepared by S.P. Raychaudhury; published in the Bulletin of the National Institute of Sciences of India, No.3, 1954, p.188; Raychaudhury, S.P., et al, Soils of India, New Delhi, 1963. A soil survey of the districts of Basti, Gorakhpur and Deoria was presented by the Agricultural Chemists during 1942-46 and in 1943, B.K. Mukerji, R.R. Agarwal and S.K. Mukerji together studied the Soils of Gorakhpur and Deoria districts in relation to sugarcane cultivation. By a genetic method of the soil study they distinguished three types of the soil viz., type I, II and III. The first type includes the calcium soils with a large reserve of lime locally known as bhat. The second type is described as "partially leached calcium soils under-laid with a bed of calcium carbonate". The third type comprises "the leached calcium soils", the texture of the soil being mostly sandy loam. All these studies do not, however, serve the purpose since they are presented with a specific aim and do not include the entire region.

In 1950 a sample soil survey scheme was initiated by the Government of Uttar Pradesh based on A.B. Stewarts report, Soil Fertility Investigations in India with Special Reference to Manuring. The soils from the field of sample villages were analysed and a texturial classification of it was published in four volumes entitled, 'Soil Survey and Soil Work in Uttar Pradesh, Allahabad; The districts of Gorakhpur and Basti had been surveyed by the Agricultural Chemists during 1942-46 and in 1943, Mukerji studied the sugarcane soils of Gorakhpur and Deoria districts.

even that of Uttar Pradesh, prepared from time to time by various authorities, give a generalized picture and valuable information of the soils of this region.[2] In addition to these, the settlement reports and the district Gazetteers also provide informations regarding the soils of this region.[3]

The classification of soils on the basis of colour, texture, availability of water and the level of land has been attempted in these records. This classification was undertaken for the assessment of revenue, and the classification is mainly empirical in nature. Each type of soil has been given local names such as matiyar, domat, balua and dhankar which have also been adopted in the region during the consolidation of holdings. On the basis of such information and personal observations, an attempt has been made by the writer to classify the soils of the Sub-Himalayan East and to examine their areal distribution (Fig.8).

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2 Hailey, H.R.C., Final Settlement Report of the Gonda District, Allahabad, 1903.

Hooper, J., Final Report of the Settlement of the Basti District, Allahabad, 1891.

Chruickshan, A.W., Report on the Settlement of the Gorakhpur District, Part I and II, Allahabad, 1891.

3 District Gazetteer, Gonda, Naini Tal, 1905.
District Gazetteer, Basti, Allahabad, 1926.
District Gazetteer, Gorakhpur, Allahabad, 1929.

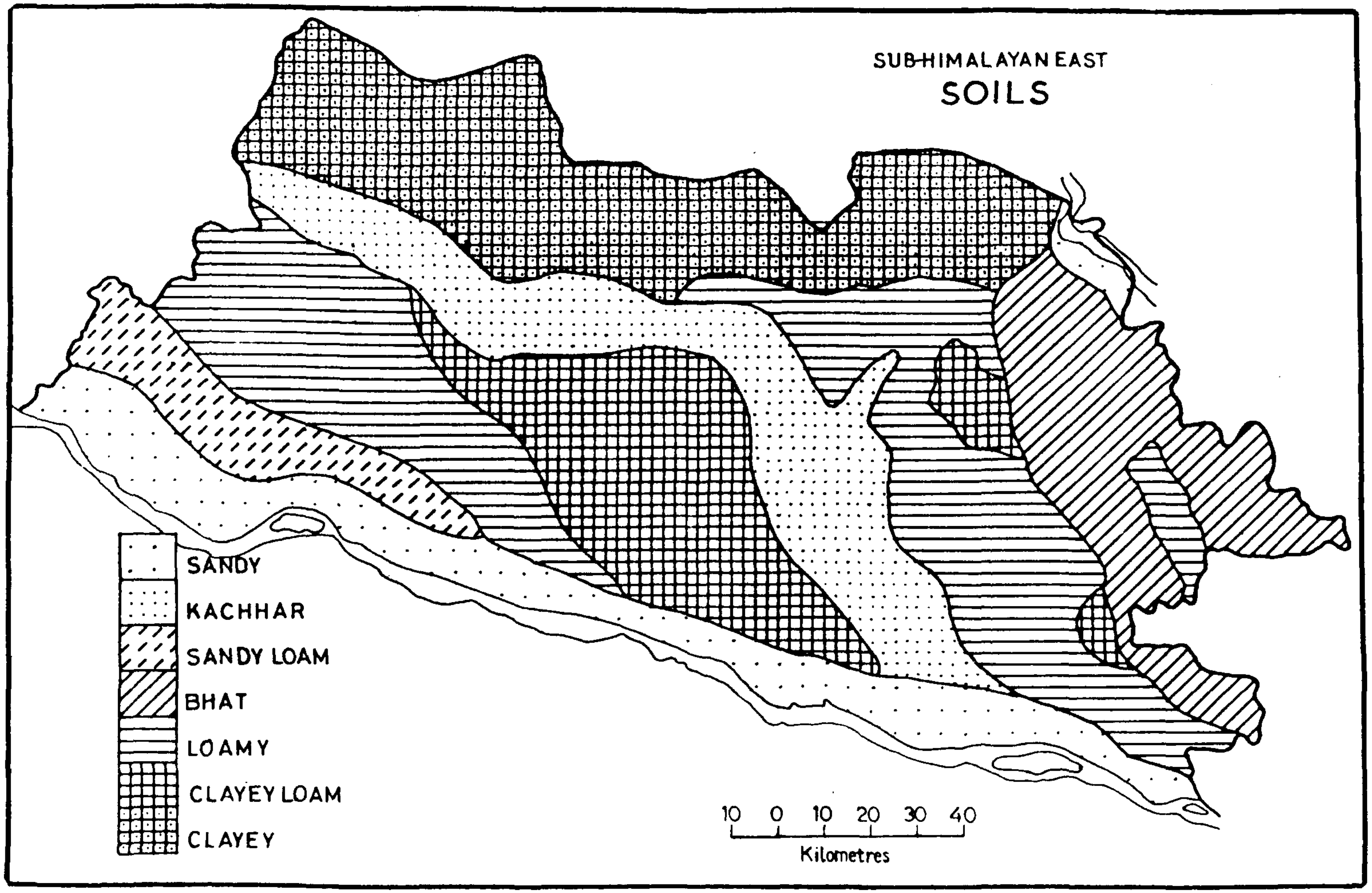
SUB-HIMALAYAN EAST
SOILS
SANDY
KACHHAR
SANDY LOAM
BHAT
LOAMY
CLAYEY LOAM
CLAYEY
10 0 10 20 30 40
Kilometres

FIG. 8

The soils of the region which are made of the alluvium brought by the Rapti, Ghaghara and Gandak rivers, have been very much affected by the local climatic and vegetative conditions and topography. The proximity of the Himalayan ranges has also greatly shaped the nature of the soils from where the parent rock materials are brought down by the rivers and deposited in the plain. The zonal differentiation in the parent rock materials has in turn given a distinct characteristic to each type of soils.

Geologically, the alluvial deposits of the region fall into two divisions to which one more may be added: khadar or new alluvium are generally light in colour owing to the higher amount of sand present in its composition, bhangar or old alluvium having more clayey and silty compositions, are generally grey to dark in colour, and bhat having considerable amount of calcareous matters or lime contents, appear white or whitish grey on the surface. Bhangar corresponds with middle-Pleistocene age and the khadar with the Recent, while the bhat seems to be formed in the intervening period.[4] Casual distinction between these three is somewhat difficult

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4 Krishnan, M.S., op. cit., p.529.

but usually the old alluvium are spread over the higher ground and the newer ones occupy the lower ground in the vicinity of the rivers, while the bhat is found in low depressions not necessarily in the immediate neighbourhood of the rivers.

Any classification of the soil in the region would follow these three main types of deposits. The khadar deposits are generally found in the neighbourhood of the rivers Rapti, Ghaghara and Great Gandak and represent the most recent soil material liable to be renewed every year by these rivers. The maximum width of the khadar deposits are confined to the southeastern extremity of the region along the bank of river Ghaghara and to that part where Rohini river is joined by the river Rapti. The soils of the khadar range in texture from gravel and coarse sand in the upper courses and in the close neighbourhood of the river beds to the fine sand and silt in the lower courses and on the borders of the bhangar. During the time of heavy floods the whole tract of low khadar lands is usually covered by water and rabi sowing is suspended till the water recedes and dries up completely. One marked phenomenon of the khadar is that the ground level is gradually raised with the successive deposits of alluvium till the land becomes free from the annual inundations. In such case the khadar becomes very productive and the fertility deteriorates only when the river suddenly carves out new channel through them and takes away the raised land with it.[5]

The bhangar represents the gently sloping plain above the flood level of the rivers where soil varies in texture extensively depending upon the nature of topography and drainage. The soil varies from sandy loam, where the drainage is not impeded, to silt and clay where it is checked. Sometimes the alluvial deposits of bhangar land contain a good deal of kankar nodules in the form of irregular concretion of lime which are formed due to the segregation of calcareous matters.[6] The patches of the saline and alkaline (usar) soils in the bhangar is not an unusual phenomenon which often interrupt with the fertile land. Such types of soil are not very well marked and do not occupy very extensive area.

Bhat is said to be the calcareous alluvium occupying the low-lying areas in the eastern part of the

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5 Raychaudhary, S.P. et al., Soils of India, New Delhi, 1963, p.44.

6 Wadia, D.N., op. cit., p.394.

region. The texture of bhat varies from sandy loam to clay and the colour also varies with the texture, where the texture is sandy the colour is white, but emerges into ash grey as the texture becomes clayey. Bhat in occupying low level country resembles the khadar and in its texturial similarity it is much close to bhangar. This is perhaps the reason that bhat could not find any exclusive treatment in any description of geology.

KHADAR SOILS

The variations in the texture of khadar soils along the banks of Rapti and Rohini rivers and that of Ghaghara and Great Gandak rivers are well marked since the former contains large amount of fertile silt and the latter consists of undue amount of coarse sand which renders the soil less productive. The khadar soils may, therefore, be classified into (i) sandy soil and (ii) kachhar soil.

(i) Sandy Soil (Balua)

Sandy soil is confined to a narrow tract along the bank of Ghaghara and that of Great Gandak in the northeastern extremity of the region (Fig.8). It owes its origin to the annual inundations of these two rivers by which a fresh cover of sandy alluvium is spread over. The sandy soils vary greatly in their composition from place to place depending upon the distance from the river-bed. In the immediate neighbourhood of the rivers the deposition of alluvium consists of comparatively big particles of sand and gravel while farther away the size turn to be minute particles and percentage of the silt gradually increases in the soil. The sandy soils neither show any sign of profile nor they have collidal or base exchange properties by which they may retain water and humus contents. The soil appear grey to ash grey on the surface. It dries up completely during summer season and leaching takes place with the heavy rain-water during wet monsoon months. Water table in the soil is always high which lies close to the surface during the rainy season and goes to a depth of only two metres during summer. The khadar soil, therefore, needs no irrigation in any cropping season. Agriculture, however, becomes precarious owing to the water-logging and floods atleast during the kharif season. Some millets, pulses and other early maturing crops are grown in this type of soil besides a good harvest of <u>zaid</u> crops like melons, water-melon and creeping vegetables which additionally help in the nitrogen fixation.

(ii) Kachhar Soil

This soil is streched over a narrow belt along the banks of Rapti and Rohin rivers. These rivers deposit fine sand and silt every year in their shallow basins when they are swollen considerably during the wet monsoon months. The silty deposits confer great fertility on the soil but the nature of the deposits is much controlled by the amount and velocity of flood-water and topography. The water-table in this type of soil ranges from two metres in the rainy season to six metres during the dry summer. The water-holding capacity of the soil is high and the upper profiles remain generally moistened. With the result the crops sown in this soil need very little irrigation in any season.

The most common crops of the areas bearing this soil are sugarcane, rice, maize and <u>arhar</u> (Cajanus Indicus) during the kharif season and wheat, barley, lentil and peas during the rabi season.

<u>BHANGAR SOILS</u>

Variation in the texture of bhangar soils is great which ranges from sandy loam to silty clay. These soils of the region according to their texture may be divided into (i) loamy (ii) clayey loam and (iii) clayey.

Loamy Soils (Domat)

Among the bhangar soils loamy is the most fertile soil which occupies a considerable portion of a generally well-drained plain, Drainage is impeded only where there is an accumulation of kankar pan near the surface at a depth of only about one metre. In their texture loamy soils are either sandy loam or silty loam with high amount of organic matters and iron contents . On the surface its colour varies from yellow to raddish brown but in its subsequent layers below the surface the organic matter deteriorates gradually and the texture tends to be more silty. As the clay particles in the soil is only limited and the soil has light texture, it does not have a high water-holding capacity. The scientists of 'Soil Survey and Soil Works in Uttar Pradesh'[7] have given the morphological, physical, chemical and mechanical characteristics of sandy to loamy soils (Table 2). These soils have been categorized into Type I group.

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7 Soil Survey and Soil Works, Uttar Pradesh, Allahabad, Vol.I, 1950.

Table 2

Morphological, Physico-chemical, Chemical and Mechanical Analysis of Type I Soil (Sandy to Loam)

Horisons depth (in cm)	0 - 23	23 - 41	41 - 107	107 - 152	152-183
1	2	3	4	5	6
<u>Morphological</u>	Dark Grey, Sandy Soil, Structure-less, acidic reaction	Greyish Yellow sandy loam single grained acidic reaction	Greyish yellow; clayey loam with iron nodules; single grained; acidic reaction	Greyish yellow silty loam; iron nodules; single grained; acidic reaction	Yellow; sandy; friable, structureless, acidic reaction
<u>Physico-chemical</u>					
Moisture holding capacity %	40.94	43.73	49.49	46.71	50.68
pH	5.9	5.7	5.8	5.5	5.8
Total exchangeable bases m.e. %	5.0	9.4	10.4	13.6	10.8
Exchangeable calcium m.e. %	2.8	6.2	6.2	7.4	5.8
Exchangeable magnesium m.e. %	2.0	3.0	3.2	5.0	4.0
Exchangeable Na + K m.e. %	0.2	0.2	1.0	1.2	1.0
Calcium Saturation %	56.0	65.9	59.6	54.4	53.7

contd......

Table 2 (Contd........)

1	2	3	4	5	6
Chemical					
Moisture (air dry) %	1.08	1.81	2.17	2.59	1.31
Loss of Ignition %	1.49	2.72	2.90	2.85	1.80
Hcl Insolubles %	87.31	81.01	79.59	78.81	84.08
Sesquioxides %	9.90	10.7	12.0	11.38	9.1
Fe_2O_3 %	2.56	2.72	3.68	3.92	3.70
Al2 O_3 %	7.28	8.20	8.28	7.40	4.32
P_2O_5 %	0.06	0.08	0.04	0.06	1.08
Ca O %	0.34	0.31	0.53	0.53	0.45
Mg O %	1.07	1.21	1.53	2.14	1.77
K2 O %	0.26	0.33	0.40	0.32	-
Water soluble salts %	0.04	0.03	0.02	0.02	0.02
Carbonates as Na2 CO2 %	Nil	Nil	Nil	Nil	Nil
Bicarbonates as Na HCO2 %	0.015	0.008	0.004	0.004	0.006
Chlorides as Na Cl %	0.014	0.018	0.007	0.006	0.008
Sulphates as Na2 SO4 %	Nil	Nil	Nil	Nil	Nil
Organic Carbon %	0.32	0.47	0.14	0.12	0.08
Total Nitrogen %	0.06	0.05	0.04	0.04	0.03
Mechanical					
Coarse sand %	0.86	0.39	0.15	0.13	0.14
Fine sand %	55.84	39.92	33.99	15.90	60.05
Silt %	32.52	35.65	44.77	61.77	30.83
Clay %	9.78	22.23	21.38	21.23	9.25

Type I soils have more mature profiles. They have been very intensively cultivated and have reached a high level of agricultural development. Higher rainfall of the area have brought about intense leaching in the profiles so that the soils exhibit acidic reaction. In the profile the leaching is clearly visible by the illuviation of sesquioxides, iron and clay to the lower depths. Leaching has gone to such a stage that even the exchange complex has been affected and calcium has been partially replaced by magnesium and even hydrogen. Organic matter and total nitrogen are much lower than in the other soils. Soluble salt contents of these soils are also low. The water retentive capacity of these soils is low due to open and lighter texture.

Loams are the most fertile soils of the region next to bhat soil which grow rabi as well as kharif crops most successfully if they are supplied with organic manures and irrigation water. They produce a variety of crops and are best suited for maize, rice-broadcast, arhar, millets and sugarcane in kharif and wheat, barley, peas, gram and potatoes in the rabi season.

Clayey Loam (Matiyar)

Clayey loam is a heavy soil in the sense that it has more clay and silt particles than loamy soils. As compared to loam, clayey loam has a high water retaining capacity because the fine particles are washed out from the higher ground and are accumulated in the depressions which increase its water retention capacity. The morphological, physical, chemical and mechanical characteristics of clayey loam to clayey soils (Type II) is given in Table 3.[8]

The nature of the soil is sticky and the texture is somewhat between loam and clay. The formation of kankar pan at shallow depths is not an unusual phenomenon. The soil below the kankar pan is usually sandy and gradually the percentage of clay diminishes with depths. The soluble salt contents are high in the soil which sometimes accumulate in the sub-soil through the process of capillary action and if the soil is ploughed deep, they come up to the surface and make it less fertile.

The soil is brownish to grey in colour according to the variability in texture and organic matters. An undue amount of clay particles present in the soil impede

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8 ibid., Vol.I, 1950.

Table 3

Morphological, Physico-chemical, Chemical and Mechanical Analysis of Type II Soil (Clayey loam to clayey)

Horizon depth (in cm)	0 - 30	30 - 60	60 - 90	90-120	120-150	150-180
1	2	3	4	5	6	7
Morphological	Yellowish grey, clayey loam, hard soil, cloddy structure moderately alkaline	Same as in col.2	Same as in col.2 but specked with brown spots of ferrous iron	Greyish yellow, clayey loam, hard soil, alkaline calcareous, small kankar nodules present	Yellow, clayey loam, alkaline, calcareous, big kankar nodules present	Yellow sandy loam, alkaline, calcareous, kankar nodules present
Physico-chemical						
Moisture holding cap. %	75.74	53.22	49.80	45.92	41.23	40.82
pH	8.1	7.4	7.7	8.0	7.9	8.1
Total Ex.Bases m.e. %	14.05	13.27	16.01	14.85	14.01	14.85
Ex. Calcium m.e. %	10.97	11.21	11.87	10.87	10.65	10.97
Ex. Magnesium m.e. %	2.58	2.74	2.86	2.88	2.98	2.84
Ex. Na + K m.e. %	0.50	0.32	1.28	1.10	0.38	1.04
Calcium saturation %	78.0	84.5	73.8	73.2	76.0	73.9

contd........

Table 3 (Contd.........)

1	2	3	4	5	6	7
Chemical						
Moisture (air dry) %	2.78	2.86	2.95	2.88	1.84	2.25
Loss on ignition %	1.26	2.11	2.62	1.55	2.27	1.77
Hcl insolubles %	82.49	76.92	85.79	77.15	74.77	73.21
Sesquioxides %	9.66	13.88	4.99	13.39	9.21	10.76
Fe_2 O %	4.56	4.72	3.92	3.12	3.04	2.48
Al_2 O_3 %	4.92	9.07	0.92	10.16	6.02	8.24
P_2 O_5 %	0.08	0.09	0.15	0.09	0.14	0.14
Ca O %	0.73	0.87	1.18	2.66	6.08	4.82
Mg O %	1.30	2.10	1.76	1.52	1.50	1.46
Water soluble salts %	0.09	0.06	0.07	0.08	0.07	0.08
Carbonates as Na_2CO_3 %	Nil	Nil	Nil	Nil	Nil	Nil
Bicarbonates as Na HCO_3 %	0.05	0.05	0.05	0.05	0.06	0.05
Chlorides as NaCl %	0.03	0.01	0.01	0.01	0.01	0.02
Sulphate as Na_2 SO_4 %	Nil	Nil	Nil	Nil	Nil	Nil
Organic Carbon %	0.25	0.19	0.16	0.12	0.11	0.09
Total Nitrogen %	0.038	0.031	0.048	0.029	0.034	0.024
Mechanical						
Coarse sand %	0.27	0.27	0.11	0.05	0.03	0.05
Fine sand %	44.37	20.65	23.97	44.01	43.11	46.79
Silt %	27.57	38.15	39.23	28.00	20.20	20.73
Clay %	21.00	29.75	28.37	17.73	18.33	17.92

the drainage. The water-table in the soil is not so high as in khadar or bhat soils. During the dry periods the soil hardens to a high degree of consistency and ploughing becomes difficult but it attains plasticity when it is wet. The soil usually requires irrigation for rabi cultivation, and these facilities are provided mostly by tube-wells.

The lands covered by clayey loam soil produce good crops of rice both broadcast and transplanted, arhar and small millets in the kharif season and principal grain crops like wheat, barley, peas, lentil and gram in the rabi season.

Clayey (Dhankar)[9]

Clayey soil is confined to a vast tract of the northern tarai region which is a large shallow basin where fine particles of clay and silt are accumulated after having been washed down by the hill torrents from the sub-mountain tract of the Nepal Himalayas. The percentage of clay constituents in the soil ranges between 40 and 45 and this increases its water retention power. In view of its low-lying character and holding stagnated water

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9 'Dhankar' is derived from the Hindi word 'dhan' (rice) meaning thereby the soil that produces rice.

for a longer time, transplanted rice is cultivated satisfactorily in this type of soil.

The formation of this soil has been ascribed to impeded drainage and hydrologic elements working in place of the normal processes of soil formation in the zonal pedogenic complex of the tract.[10] Through the leaching process which is a usual phenomenon in this type of soil, a heavy amount of calcium carbonate is washed down to accumulate at the depth of 0.75 metre to one metre by which kankar - pans are formed. These kankar - pans check free movement of water and the soil thus, suffers from poor drainage. Aeration is also poor in this soil. The colour of the soil varies from grey to dark grey depending upon the amount of humus and clay contents present in it. A large amount of biological and botanical remains are continuously added which increase the status of humus and nitrogen in the soil.

Dhankar soil is so tenaceous that it can not be worked out if not well moistened. It hardens to a very high consistency when dry, giving way at the same time

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10 Raychaudhary, S.P., et al., op. cit., p.354.

to cracks. During the wet monsoon months it attains the characteristic of molten plastic and causes inaccessibility. Water-table is always high ranging between one metre from the surface during rains to 2 or 3 metres during dry months. In extreme cases, soluble salt may occur in the sub-soil but it does not lead to salinization on the upper horizon of the soil.

The soil is highly suitable for transplanted rice which constitutes the bulk of the annual harvests. Owing to the difficulty of ploughing during the rabi season, rabi crops are not extensively grown. Some of the rabi crops like barley, gram, lentil and peas are grown in this soil but they usually give a poor return.

Calcareous Soil (Bhat)

Bhat is a typical calcium soil found in the depressions which is calcareous in nature though in its texture it resembles the soils of the bhangar land. The soil is formed of the alluvium brought by Great Gandak and Little Gandak rivers in which the percentage of lime ranges from 25 to 30. It is due to this amount of lime that the soil at the surface appears to be white in colour.

These soils are generally low-lying, single-grained in structure and sandy loam to silty loam in texture.[11] Where its texture is sandy loam, it is relatively white in colour and where the texture is silty or clayey loam it tends to be ash grey. In its chemical composition bhat is distinguished from the bhangar soils by the large proportion of carbonate of lime, magnesia and alumina.

Bhat soils are alkaline in reaction owing to a high amount of calcium carbonate or kankar nodules present in the soil in precipitated form. But at the same time these soils have high capacity of moisture retention. The water-table is always high which remains at the depth of only 0.5 metre during the season of rains and a maximum depth of 2 metres, during the summer months. Being well-moistened and well-drained bhat is pre-eminently suitable for sugarcane cultivation which is carried on without the help of irrigation year after years on the same fields. The high water-table is sometimes responsible to aggravate the condition favourable for the accumulation of soluble salts on the surface in which the soil is

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11 Raychaudhary, S.P. et al., ibid., p.370.

moderately rich. If, however, a higher amount of salt comes up the soil is rendered unproductive.

The calcareous soil is confined to a vast tract of land lying mostly between Great Gandak and Little Gandak rivers including a narrow strip extending to the west of the Little Gandak river, with the exception of a narrow belt of the loamy soil (Fig.8).

Bhat soil contains adequate amount of potash but low amount of organic matters and nitrogen. The supply of organic matter is increased by growing sun-hemp and with the application of animal waste. The decomposition of green matter is facilitated by an adequate presence of lime and moisture. The bhat soil is famous for its high fertility and produces almost all crops suited to the local climatic conditions. Sugarcane is extensively grown in this soil which gives higher return. Other important kharif crops produced are rice, arhar, big and small millets. Among the rabi crops wheat, barley, peas, khesari (pulse) and sweet potatoes are harvested.

Saline and Alkali Soil

These soils are found in the region in discontinuous, irregular and small patches which are not easy to be located precisely on a map without any detail soil survey. Sometimes saline and alkali soils interrupt the most fertile lands. The study of the components of soil reveals that almost each soil type has some amount of injurious salt but it does not produce any adverse effect on the soil as it is found in a limited quantity. Only when the salt increases beyond a certain limit, it begins to interfere with the plant growth. The salt by physical action makes the soil pressure stronger than that of the cells of the plants, and the water instead of passing from soil to the root of the crops, passes from the roots to the soil. The crops consequently perish.[12]

On the basis of the salt contents and the percentage of the exchangeable sodium present in these soils, they are classified into saline, saline-alkali and alkali soils.[13] Saline soil is known as <u>reh</u> which represents an ash-white encrustation on the surface. The accumulation of reh takes place through the process of capillary action. During the wet monsoon months, the soluble salts go below the surface dissolved in the water

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12 Howard, H., <u>Crop Production in India</u>, London, 1924, p.44.

13 Shafi, M., 'The Problems of Wasteland in India', <u>The Geographer</u>, Vol.XV, 1968, p.3.

and during the dry summer season as a result of capillary action it again comes up on the surface. The water is evaporated leaving behind salt afflorescence or reh. The saline-alkali soil is known as usar though the typical usar is the alkali land. The formation of usar generally occurs in clayey loam or clayey soils which are associated with kankar pans found at a depth of 0.50 metre to one metre. These kankar pans restrict the upward movement of the water by capillary action though downward flow of water takes place by percolation under the force of gravity. This peculiar phenomenon in the soil turns the fertile soil into usar lands.

The formation of saline soil or reh occurs generally in the loamy and sandy loam soils where there is no kankar accumulation in the sub-soil. These are spread in small patches, amidst the vast tract of the loamy soils of the region. Usar soils on the other hand, have made their way in the tarai and kachhar soils which have more clay-components alongwith the deposits of kankar nodules in the sub-soil profiles.

PART III

PATTERN OF AGRICULTURAL PRODUCTIVITY AND DIMENSIONS OF REGIONAL DEVELOPMENT

CHAPTER VII

PATTERN OF AGRICULTURAL PRODUCTIVITY

Agricultural productivity is one of the components of regional development. It is a multi-dimensional concept which includes number of complex factors viz. environmental, technological and institutional. These factors affect the agricultural development of a region.

It may be pointed out that the agricultural development should be assessed by the agricultural production and productivity, and also by the various physical inputs - extent of cultivated area, irrigation, fertilizers, improved seeds, and labour availability. If assessed in this manner, agricultural development may constitute as one of the significant components of regional development. Because it provides increased food surplus to the growing population, helps to expand the secondary and tertiary sectors, increases rural incomes and improves the welfare of the population of the region.

The concept of integrated agricultural development means viewing agriculture not as a separate sector but rather as a branch of the economy completely integrated into the development process and contributing to the fulfilment of the objectives which society as a whole has set for itself. It may be noted that agricultural surplus increases the rural incomes which tend to improve the rural life of the area. This surplus gives the chance to the villagers to consume more nutritive food in the form of superior quality cereals, eggs, ghee (refined butter), milk, fruit etc. They build better houses, get vehicles and also receive the facilities such as irrigation, banking, transport, schools, health centres etc. Thus increased agricultural surplus plays a vital role in raising the standard of living of the overwhelming majority of the rural population of an area. In this context it is felt that the approaches which are preferable in the fields of agricultural productivity should be selected in the present study appropriately. The selected approaches should be sensitive enough to explain quite a sizable proportion of the total variation in the agricultural productivity.

The regional variations in the pattern of agricultural productivity of the Sub-Himalayan East have been assessed by applying five methods of the evaluation of agricultural productivity. Development block of the area is taken as the unit of the study. All the crops[1] grown in the region have been considered for the computation of the productivity taking five years average from 1978-79 to 1982-83. For the population of agricultural workers census data of 1981 are used.

The following five methods have been adopted for measuring the agricultural productivity of the area under study.

1. Agricultural Productivity: Based on Standard Nutrition Unit (per hectare of cropped land)

Stamp[2] used this method for the measurement of productivity. Its purpose is to convert the total production of crops per hectare into calories and to establish the extent of relationship between the agricultural production i.e., the availability of agricultural output in terms of nutrition to support the number of persons per hectare of cropped land. Stamp assumed 10,00,000 calories as the Standard Nutrition Unit (SNU). Shafi[3] on the basis of his surveys in Eastern

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1 Cereals, pulses, oilseeds, sugarcane, groundnut, tobacco, cotton, jute, hemp, turmeric and potato.

2 Stamp, L.D., Our Developing World, op. cit., p.110.

3 Shafi, M., Land Utilization in Eastern Uttar Pradesh, op. cit., p.222.

Uttar Pradesh has put 8,00,000 calories as the Standard Nutrition Unit for India. For the purposes of the calculations the value of 8,00,000 calories has been adopted. The food crops were taken for the computation of caloric output in the unit area.

2. Agricultural Productivity: Based on Agricultural Output Per Hectare of Cropped Land (price weighted)

This method of productivity measurement has certain advantages, because land is the most permanent and fixed among other factors for evaluating productivity. Recently it has assumed a special attention due to population explosions and the relative returns from it. In order to evaluate productivity indices in each block farm level harvest prices for the coresponding years have been incorporated. This gives the agricultural output per hectare (in Rs.). These indices of a farm output have been computed by multiplying the harvest price to the production of crop concerned. These products were finally added up and divided by the total crop area to get the value of output per hectare (in Rs.).

3. Agricultural Productivity : Based on Agricultural Output Per Agricultural Worker (price weighted)

Agricultural productivity can also be assessed by evaluating the returns per agricultural worker engaged in the farming. It can be assessed by multiplying the production by the price (harvest) and the product is to be divided by the population engaged in the production process of the crop.

4. Agricultural Productivity : Based on Bhatia's Productivity Index

Bhatia has computed agricultural productivity on the basis of Ganguli's method.[4] Bhatia first calculated the yield indices of various crops and multiplied them by the percentages of cropland under different crops and divided the sum of these by the sum of the percentages of cropland under the different crops.

5. Agricultural Productivity : Based on Shafi's Productivity Coefficient Index

Shafi modified Enyedi's method in determining the index of agricultural productivity (ChapterII).

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4 For detail, see Chapter II of this monograph.

In his formula 'the summation of the total yield of all the crops in the unit area is divided by the total area under those selected crops considered in the unit area and the position thus obtained is examined in relation to the total yield of all the crops considered at the national level divided by the total area under those crops'.

AGRICULTURAL PRODUCTIVITY REGIONS

A uniform technique of standard deviation (SD) is used in delineating the agricultural productivity regions. The computed values of productivity indices are given in Appendix A. On the basis of these productivity indices mean and standard deviation have been calculated for each index.(Table 4).

Table 4

Parameters of Agricultural Productivity Indices

Index*	Mean	Standard Deviation	Coefficient of Variation
X_1	80.01	18.28	22.85
X_2	1649.42	596.48	36.16
X_3	974.22	303.06	31.11
X_4	100.00	27.15	27.15
X_5	-8.10	24.16	298.20

* X_1 Standard nutrition unit per hectare
X_2 Agricultural output per hectare
X_3 Agricultural output per agricultural worker
X_4 Bhatia's productivity index
X_5 Shafi's productivity coefficient index

The development blocks of the area under study were classified into five classes on the basis of variation from mean value of the productivity index. The following system has been adopted to determine the ranges of classes:

Class	Range of index
Very High	$\bar{X}$ + 1.5 SD and above
High	$\bar{X}$ + 0.5 SD to $\bar{X}$ + 1.5 SD
Medium	$\bar{X}$ - 0.5 SD to $\bar{X}$ + 0.5 SD
Low	$\bar{X}$ - 1.5 SD to $\bar{X}$ - 0.5 SD
Very Low	$\bar{X}$ - 1.5 SD and below

1. Productivity Regions : Based on Standard Nutrition Unit per hectare

This method measures the productivity of land in terms of caloric output per hectare and its capacity to support the population. The supporting capacity is calculated by measuring yields of various crops in terms of calories per unit of land and by comparing total yield of calories with its standard annual requirement per person. As such, this method of productivity evaluation gives an index of level of agricultural development in terms of standard nutrition requirements.

Standard nutrition unit per hectare in the region varies from 121.04 (Nebua Naurangia) to 44.79 (Pachperwa) (Appendix A). This variation is further confirmed by a coefficient of variation of 23 per cent.

In the regional pattern two distinct small regions of very high agricultural productivity are found (Fig.9). One lies in the northern part of Gorakhpur district and includes the blocks of Brijmanganj (120.38) and Lakshmipur (117.14). The other, which is composed of Pipraich, Sardarnagar and Khorabar form a region in the central part of Gorakhpur district of the area. The other two blocks of very high productivity grade are Nebua Naurangia (121.04) and Urwa (108.54). These blocks are far apart from each other and therefore they fail to constitute any identifiable region. Nebua Naurangia block which have very high productivity in terms of SNU per hectare is relatively caused by production of sugarcane. Urwa block also lies in the grade of very high agricultural productivity but its index is very close to the index of the high agricultural productivity. A dominant and distinctly contiguous region of high productivity grade is located in the eastern part of the area. This region includes thirty-three per cent blocks of the area. The

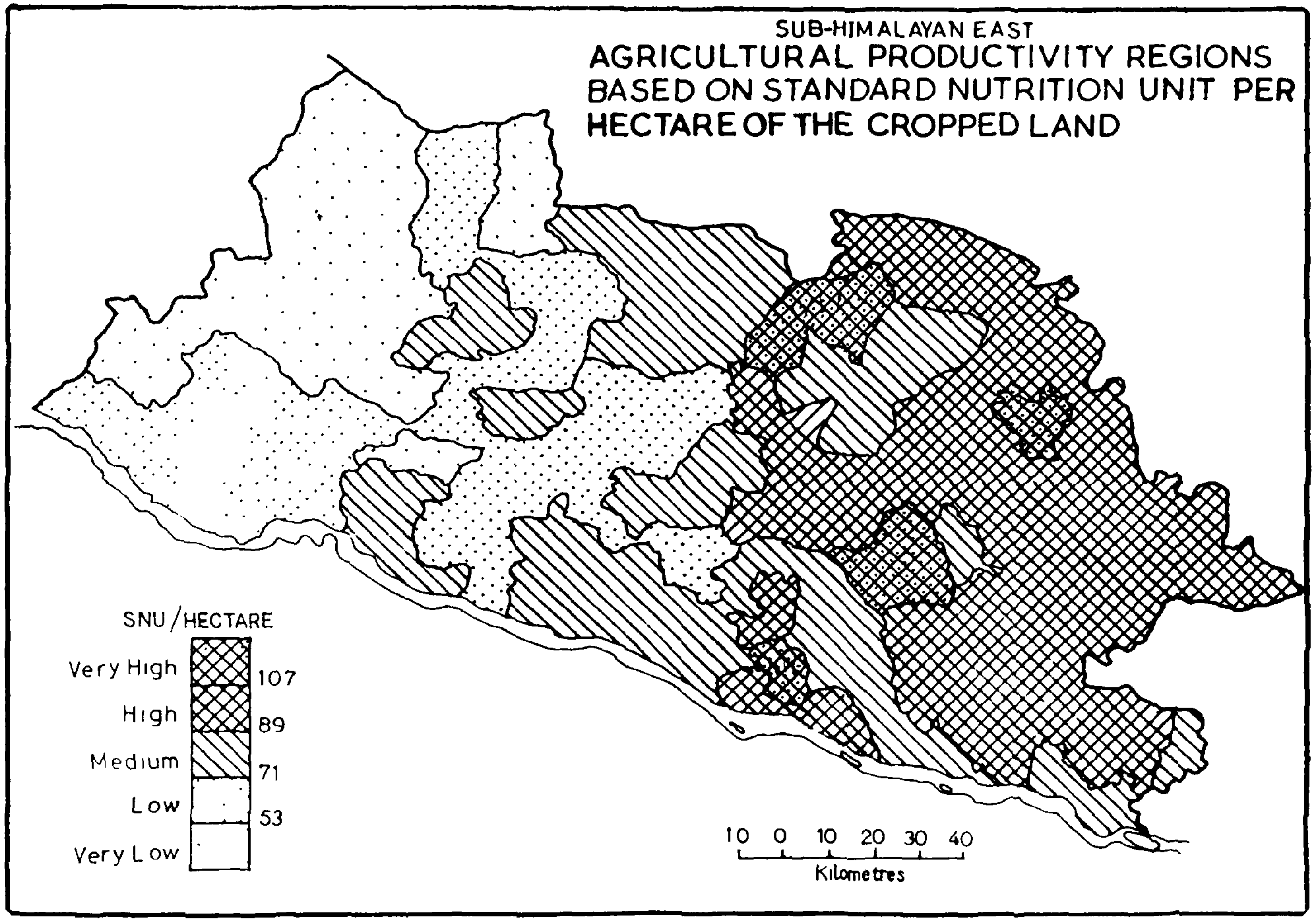
SUB-HIMALAYAN EAST
AGRICULTURAL PRODUCTIVITY REGIONS
BASED ON STANDARD NUTRITION UNIT PER
HECTARE OF THE CROPPED LAND
SNU/HECTARE
Very High
High
Medium
Low
Very Low
107
89
71
53
10 0 10 20 30 40
Kilometres

FIG.9

regions of medium productivity grade are found scattered in the central part separated at places by low productivity grade. A linear region of medium productivity lies in the southcentral part, almost along the river Ghaghara, and includes the blocks of Bahadurpur, Kudraha, Hainsar Bazar, Basti, Bankata, Nathnagar, Sahjanwa, Piprauli, Bansgaon, Kauri Ram, Gagaha and Barhalganj. The other region of the same grade is observed in the northcentral part comprising the blocks of Naugarh, Jogia, Birdpur, Barhni, Uska and Bansi. A third region of this grade is located in the northeastern part surrounded by very high and high productivity regions. The index values of these blocks are nearer to the values of the high productivity grade. The blocks included in this region are Mithaura (89.13), Pharenda (84.29), Maharajganj (83.14) and Paniara (82.86). About twenty-nine per cent of the blocks fall in the grade of low productivity index. They are mainly concentrated in the central and southwestern part of the area. The southwestern part of this grade forms a compact region comprising the blocks of Colonelganj, Paraspur, Pandari Kirpal, Jhanjhari, Mankapur, Belsar, Tarabganj, Wazirganj and Nawabganj. Eleven blocks of very low productivity grade constitute a distinct region in the northwestern part of the area. They are Haraiya

Satgharwa, Tulsipur, Balrampur, Shridattaganj, Utraula, Rupaidih, Katra Bazar, Haldhar Mau, Itiathok, Mujehna and Rehra Bazar. Two blocks of the same grade are scattered in nature and fail to constitute any identifiable region. In general, the distribution of productivity shows a marked declining pattern from southeast to northwest with few exceptions. Such patterns are due to the change in magnitude of natural and technological factors in the area. Among these rainfall, bhat soils HYVs, fertilizer and irrigation play a dominant role and are directly associated with the level of agricultural productivity. These factors have been discussed, in detail, in the last section of this chapter.

2. Productivity Regions : Based on Agricultural Output per hectare (in Rs.)

Regional distribution of agricultural productivity on the basis of output per hectare shows a wide range of variation in the Sub-Himalayan East. It varies from a minimum of Rs.747 in Pachperwa to the maximum of Rs.3259 in Nebua Naurangia (Appendix A). This variation is further confirmed by the coefficient of variation which is 36 per cent.

In the regional pattern a distinct and compact region of very high productivity grade is found in the eastern part of the area including eight block of Nebua Naurangia (3259), Ramkola (3198), Hata (2985), Padrauna (2855), Bishunpura (2804), Motichak (2669), Sukrauli (2610) and Captainganj (2557), Fig.10. The other three blocks of this grade are Siwarhi (2737), Rampur Karkhana (2733) and Bankata (2615). These blocks are far apart from each other and, therefore, they fail to constitute any identifiable region. The blocks of high productivity grade form a contiguous semi-circular region around the region of very high productivity in the northeastern part of the area. The blocks of this region, in descending order, are Baitalpur, Kasia, Khadda, Tamkuhi, Bhatpar, Desai Deoria, Gauri Bazar, Dudhai, Deoria, Partawal, Sardarnagar, Pathardewa, Ghughuli, Fazilnagar, Pipraich, Siswa, Bhathat, Nichlaul, Salempur, Chargawan, Bhatni and Lar. A large and contiguous region of medium productivity is found in the central part including about thirty-two per cent blocks of the area. The low productivity grade constitutes a compact and sizeable region in the northwestern part of the area. About thirty-six per cent of the blocks fall in this grade. A small region of low productivity is observed in the

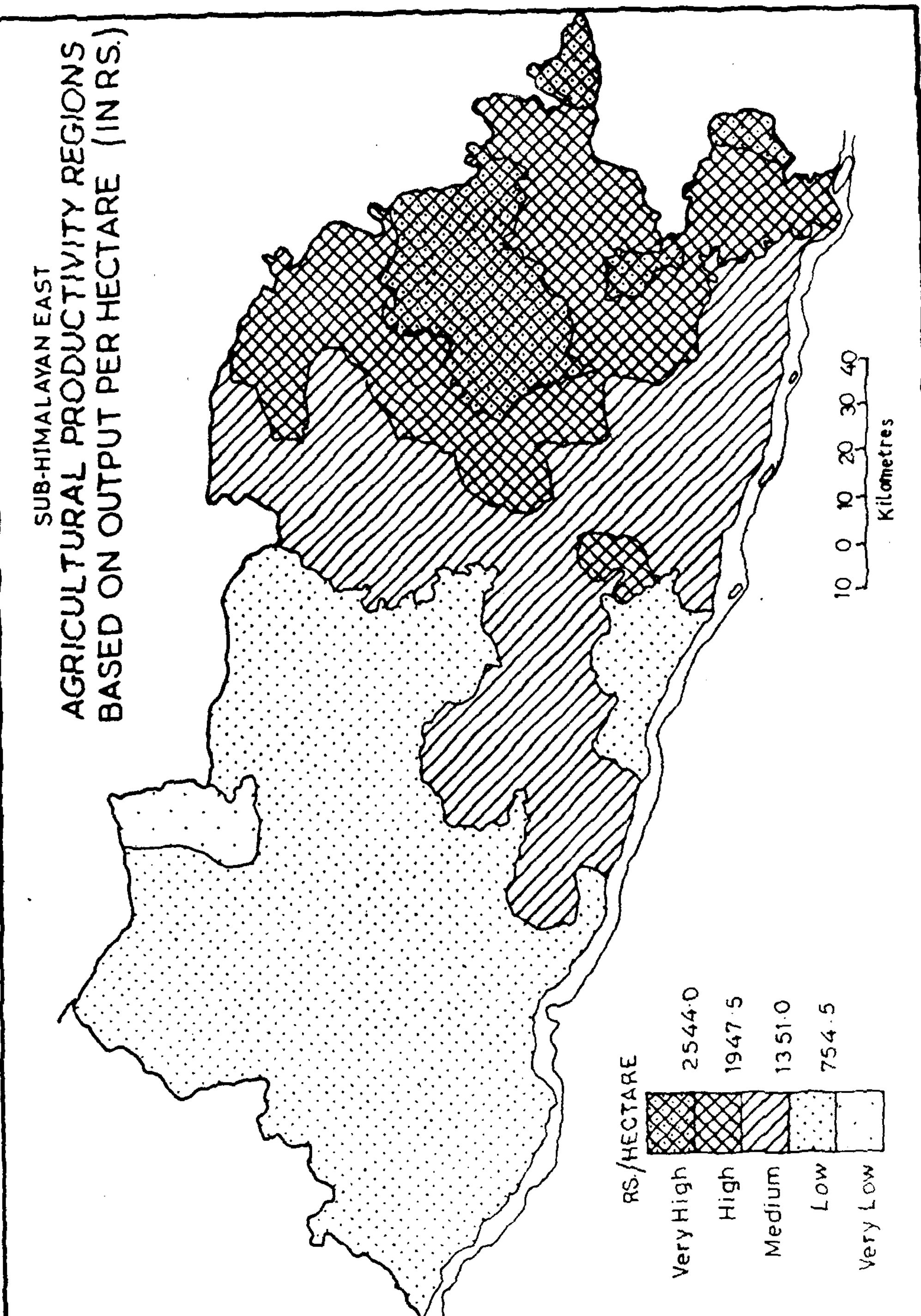
SUB-HIMALAYAN EAST
AGRICULTURAL PRODUCTIVITY REGIONS
BASED ON OUTPUT PER HECTARE (IN RS.)
RS./HECTARE
Very High 2544·0
High 1947·5
Medium 1351·0
Low 754·5
Very Low
10 0 10 20 30 40
Kilometres

FIG.10

southcentral part. The blocks of this region are Kudraha, Nathnagar and Hainsar Bazar. Only one block (Pachperwa) comes in the grade of very low agricultural productivity.

It is observed that the distribution of productivity shows a decreasing pattern from east to west. Furthermore, the productivity regions become larger and larger from east to west.

3. Productivity Regions : Based on Agricultural Output Per Agricultural Worker (in Rs.)

Agricultural productivity in terms of production per agricultural worker is far from uniform and varies from Rs.472 to Rs.1954 with a maximum index of 1953.57 in Khadda and a minimum of 472.26 in Naugarh (Appendix A). The coefficient of variation observed in the region is 31 per cent. This variation is summarized by classifying the blocks into five groups of very high, high, medium, low and very low productivity.

The distribution shows that five blocks of very high productivity grade delimit a compact region in the northeastern part of the area. They are Khadda (1953.57), Bishunpura (1856.38), Nebua Naurangia (1728.83), Ramkola (1512.96) and Padrauna (1503.94) Fig.11. The other three

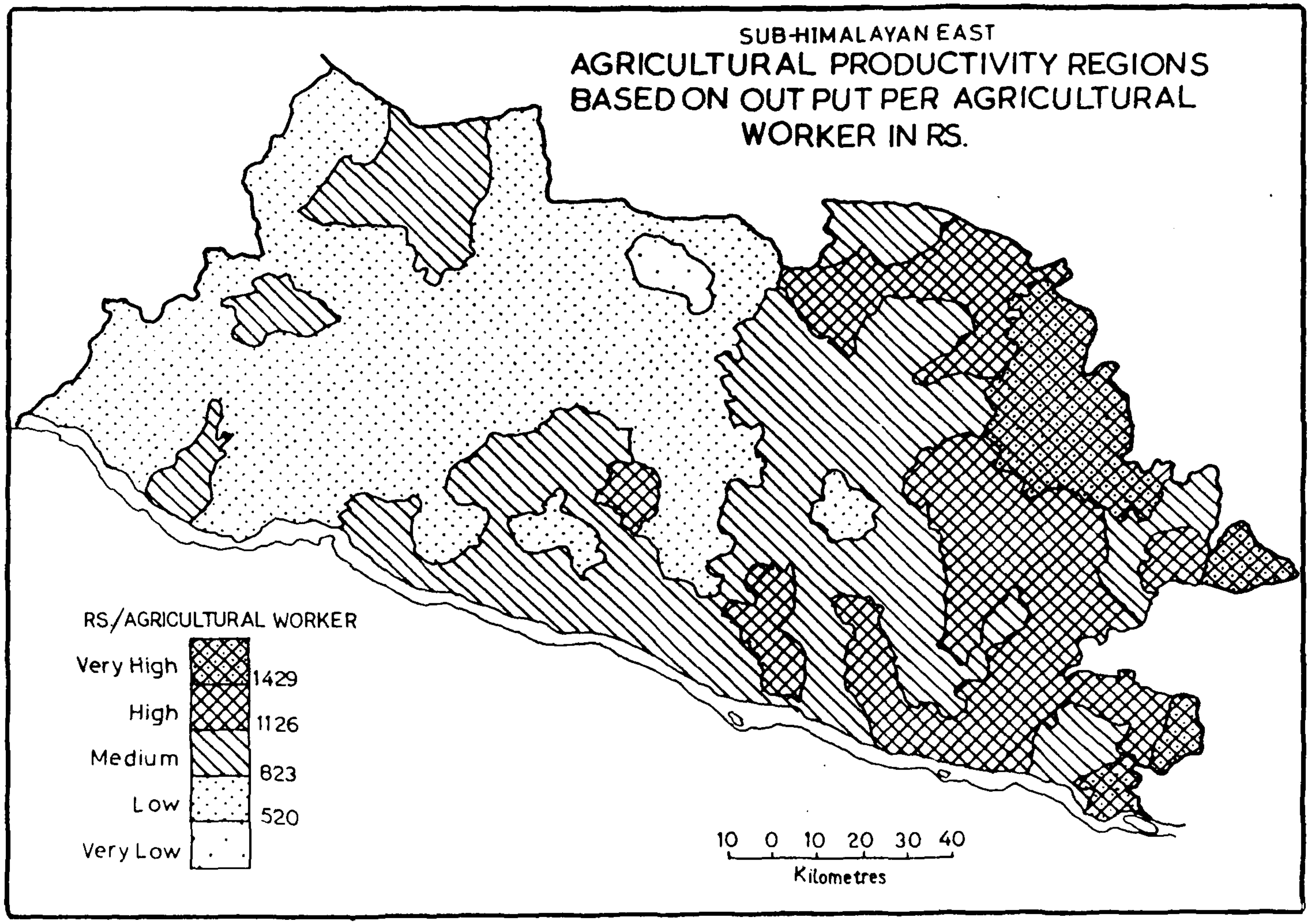
SUB-HIMALAYAN EAST
AGRICULTURAL PRODUCTIVITY REGIONS BASED ON OUT PUT PER AGRICULTURAL WORKER IN RS.
RS./AGRICULTURAL WORKER
Very High
High
Medium
Low
Very Low
1429
1126
823
520
10 0 10 20 30 40
Kilometres

FIG.11

blocks of this grade are Bankata (1530.28), Siwarhi (1513.07) and Lar (1491.41). These blocks are far apart from each other and, therefore, they do not constitute any identifiable region. In the regional pattern three distinct regions of high productivity are found. One lies in the eastern part and includes the blocks of captainganj, Motichak, Sukrauli, Hata, Kasia, Gauri Bazar, Desai Deoria, Pathardewa, Rampur Karkhana, Deoria, Bhatni, Bhatpar, Bhaluani, Barhaj, Barhalganj, Gagaha and Kauri Ram. Second region of this grade is located in the northeastern part comprising the blocks of Nichlaul, Siswa and Lakshmipur. Third region of the same grade forms a small pocket in the southcentral part including the blocks of Khazni and Urwa. The major concentration of medium productivity is found in the central and southcentral part. This region of medium productivity includes about twenty-nine per cent blocks of the area. Other small pockets of medium productivity are found scattered in the northwestern and eastern part of the area. The grade of low productivity constitutes a dominant region in the northcentral and western part of the area. This grade includes about thirty-three per cent blocks of the area. Only one block (Naugarh) falls in the grade of very low productivity in the northcentral part of the area.

4. Productivity Regions : Based on Bhatia's Productivity Index

The distributional pattern of agricultural productivity is far from uniform and varies from 49 to 130 with a maximum index of 130.76 in Belghat and a minimum of 49.39 in Pachperwa (Appendix A). This large variation is further confirmed by the coefficient of variation which is 27.15 per cent.

The distribution shows that nearly forty-eight per cent blocks of the area have high productivity index. These blocks form a single compact region in the eastern part of the area (Fig.12). Significant blocks of this grade having values closer to the maximum index are Pathardewa (130.52), Rampur Karkhana (130.18), Bhaluani (129.95), Fazilnagar (129.58) and Nautanwa (129.49). The concentration of the medium productivity level is found in the central part in which thirty-four blocks constitute a distinct region. This region of medium productivity separates the region of low and high productivity grades. One block (Nichlaul) of the medium level, situated in the northeastern part, fails to constitute any significant region. The blocks of the western part of the area are distinctively characterized with the low productivity level. They together account

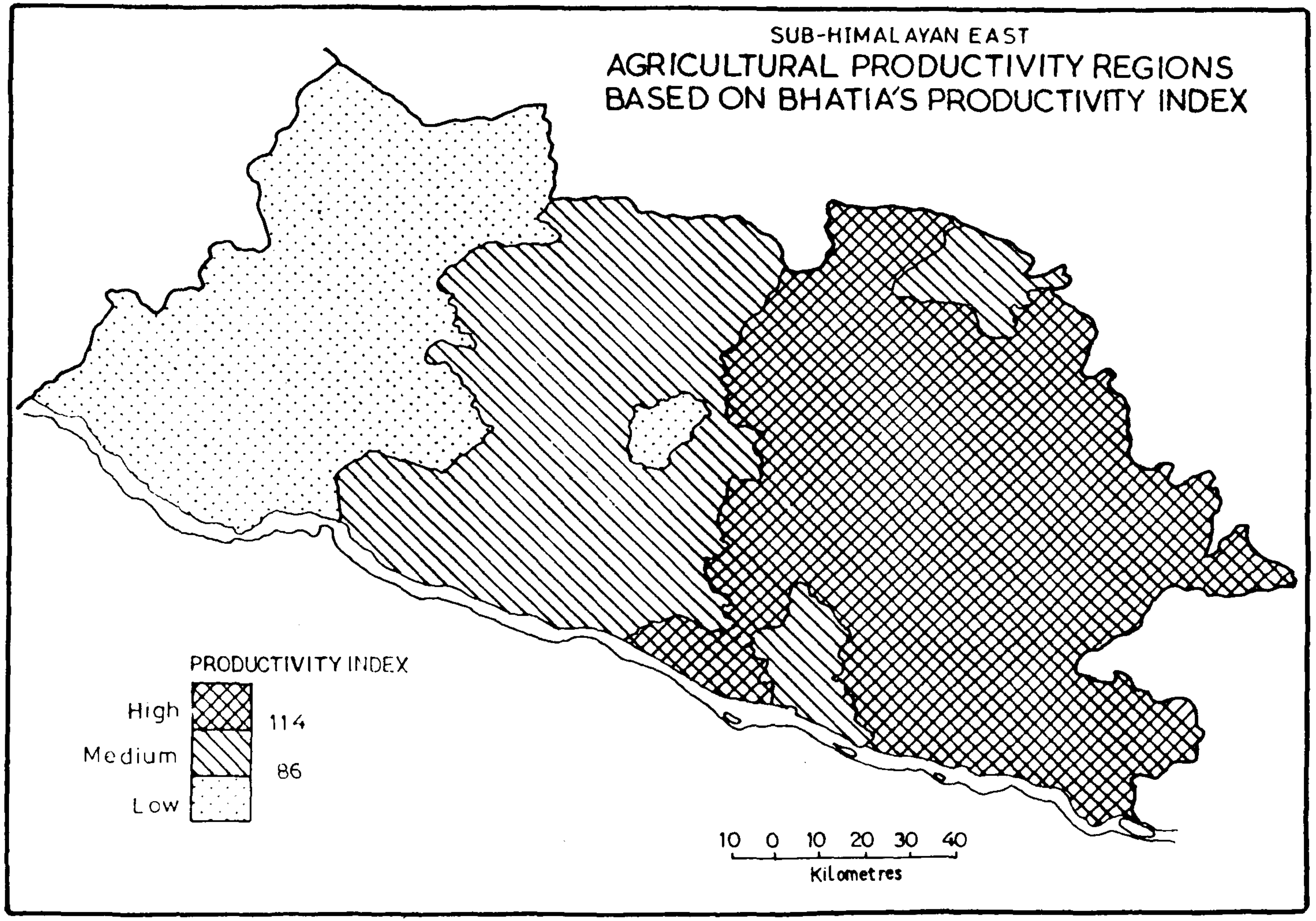
SUB-HIMALAYAN EAST
AGRICULTURAL PRODUCTIVITY REGIONS
BASED ON BHATIA'S PRODUCTIVITY INDEX
PRODUCTIVITY INDEX
High
114
Medium
86
Low
10 0 10 20 30 40
Kilometres

FIG.12

for twenty-one per cent blocks of the area. Block Santha of the low productivity grade lies amidst the region of the medium productivity having 83.72 productivity index which is nearer to the medium grade. It is interesting to note that the agricultural productivity shows a marked declining pattern from east to west.

5. Productivity Regions : Based on Shafi's Productivity Coefficient Index

A wide range of distribution of agricultural productivity is recorded in the Sub-Himalayan East as its coefficient of variation is 298 per cent. It varies from 98.46 (Nebua Naurangia) to -52.67 (Itiathok), Appendix A.

The regional distribution of agricultural productivity is shown in Fig.13. The blocks of very high productivity grade are scattered too sporadically to form an identifiable region. These blocks are Nebua Naurangia, Chargawan and Rudrapur. The grade of high agricultural productivity forms a single contiguous region in the eastern half of the area. This region accounts for forty per cent of the blocks of the area. Patches of very high and medium productivity grades are located in the region of high productivity. A compact region of medium productivity is found in the northcentral part of the area,

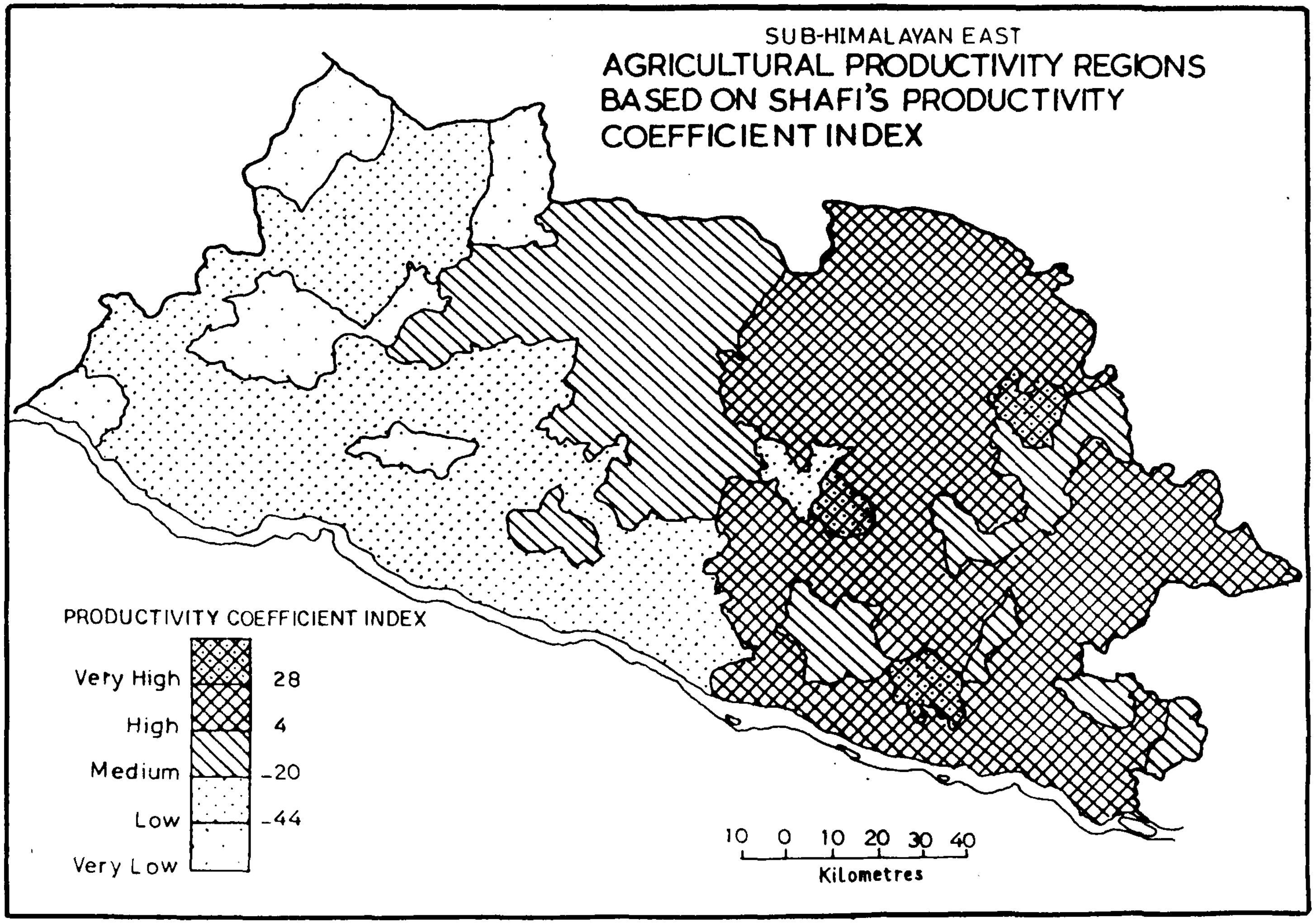
SUB-HIMALAYAN EAST
AGRICULTURAL PRODUCTIVITY REGIONS BASED ON SHAFI'S PRODUCTIVITY COEFFICIENT INDEX
PRODUCTIVITY COEFFICIENT INDEX
Very High
High
Medium
Low
Very Low
28
4
-20
-44
10 0 10 20 30 40
Kilometres

FIG 13

separating the low and high productivity regions. This region includes 14.5 per cent blocks of the area. Nine blocks of the medium productivity grade lie, in patches, amidst the region of high productivity. Their coefficient values are nearer to the values of high productivity grade. These blocks are Bishunpura (3.78), Baitalpur (3.43), Bhatni (3.25), Ramkola (3.23), Kauri Ram (3.00), Hata (2.81), Bankata (2.53), Sukrauli (2.22) and Bansgaon (-0.77). The blocks of low agricultural productivity are mainly concentrated in the western and southwestern part of the area. Jangal Kauria block of the same grade lying in the central part, in between medium and high productivity regions, fails to constitute any identifiable region. A distinct region of very low agricultural productivity is observed in the western part comprising the blocks of Itiathok, Mujehna, Pandari Kirpal and Utraula. Other four blocks of very low productivity grade are scattered in the western part and they fail to form any significant region. These blocks are Colonelganj, Chhapia, Haraiya Satgharwa and Pachperwa.

An interesting point noted in the distribution of productivity is that the eastern half of the area has high productivity in general whereas western and southwestern part have low and very low productivity. The region of medium productivity is hemmed in between low and high productivity regions in the northcentral part of the area.

COMPARATIVE STUDY OF THE METHODS STUDIED

Examination of the Table 4 reveals that the highest coefficient of variation of 298 per cent is shown by Shafi's productivity coefficient index while the lowest i.e. 23 per cent is shown by SNU per hectare. The remaining three indices exhibit a coefficient of variation from 27 to 36 per cent. It shows that Shafi's productivity coefficient index is highly sensitive to small variations in the productivity. The SNU is least sensitive to small variations. More or less the same pattern is shown by Bhatia's productivity index.

All the five indices of agricultural productivity exhibit very high degree of positive relationship. This relationship is given in Table 5 in the form of correlation coefficients.

Table 5

Correlation Matrix of Agricultural Productivity Indices

INDEX*	X_1	X_2	X_3	X_4	X_5
X_1	1.00000				
X_2	0.73682	1.00000			
X_3	0.65190	0.85325	1.00000		
X_4	0.89488	0.79324	0.71743	1.00000	
X_5	0.89651	0.72046	0.61547	0.83941	1.00000

Table 5 shows that the highest correlation (0.896) recorded is between SNU per hectare and Shafi's productivity index while the lowest (0.652) goes to the SNU per hectare and agricultural output per worker. This signifies the fact that Shafi's index has a close value to the SNU per hectare in the evaluation of agricultural productivity of the Sub-Himalayan East. The SNU per hectare also has high positive correlation (0.895)

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* X_1 Standard nutrition unit per hectare
  X_2 Agricultural output per hectare
  X_3 Agricultural output per agricultural worker
  X_4 Bhatia's productivity index
  X_5 Shafi's productivity coefficient index

with Bhatia's productivity index. A high correlation (0.853) is also found between agricultural output per hectare and agricultural output per agricultural worker. These two indices together have comparatively less correlation coefficients with the other three indices of productivity. As such, agricultural output per hectare and per agricultural worker make one set of correlation coefficients while the rest three indices together make another set of relationships.

However, it is interesting to note that all the five productivity indices are highly and significantly correlated with each other thereby signifying the fact that each one of them measures the same thing i.e. agricultural productivity, though they measure different dimensions of agricultural productivity. This is further strengthened by comparing regional patterns of productivity as observed in the case of the five indices. In general, five productivity indices show invariably a marked declining pattern from east to west. The distribution of productivity in terms of SNU per hectare shows a declining pattern from southeast to northwest with few exceptions. Agricultural productivity in terms of output per hectare and per agricultural worker show the similar distribution and they also exhibit a decreasing pattern from east to west. According to Bhatia's productivity index, the eastern region is marked by high productivity, the central region with medium productivity and the western region with low agricultural productivity. Shafi's productivity index shows more or less similar results to that of Bhatia's index but with more variations. In Shafi's index eastern half of the area observes high productivity whereas western and southwestern part have low and very low productivity. The region of medium productivity is hemmed in between low and high productivity regions in the northcentral part of the area.

FACTORS OF SPATIAL VARIATION IN AGRICULTURAL PRODUCTIVITY

The above analysis reveals that the level of agricultural productivity decreases from east to west. There are many factors at work which cause this spatial pattern of agricultural productivity in the region. Among natural factors rainfall and soils are found to be significant to explain some of the variance in the agricultural productivity. The rainfall as seen in Fig.7 shows a marked decline from north to south with a perceptible higher rainfall in the northeast. Some of the agricultural productivity indices show a regional pattern which is significantly related with the pattern of rainfall. Fig.8 shows the distribution of soils. Sandy and less fertile soils are concentrated in the west and south of the area. It is interesting to note that all the indices invariably show a high or very high level of agricultural productivity in the region of bhat soils which are found in the northeastern part of the area under study. Bhat soils have a good content of lime which is favourable for the growth of sugarcane. Sugarcane is also concentrated in the region of this soil.[5] Per hectare yield as well as money value of the crop is high which contributes to the high level of productivity in this region. Regions of loamy soils also exhibit a high productivity region which gradually changes into medium and lower levels of agricultural productivity as the content of sand in the soil increases.

Among the technological variables irrigation, high yielding varieties of seeds (HYVs), use of fertilizers and lastly the agricultural practice of multiple cropping (agricultural intensity) are found as significant correlates of agricultural productivity. So far irrigation is concerned, it shows a high and medium level of per cent area under irrigation in the southeast of the area which gradually declines towards north and west (Fig.14). It would be seen that irrigation is somewhat inversely related

5 Munir, A. and Khan, M.F., Agricultural Typology in the Sub-Himalayan East, Paper Presented at the 5th Annual Congress of the National Association of Geographers - India, Aligarh, December, 1983.

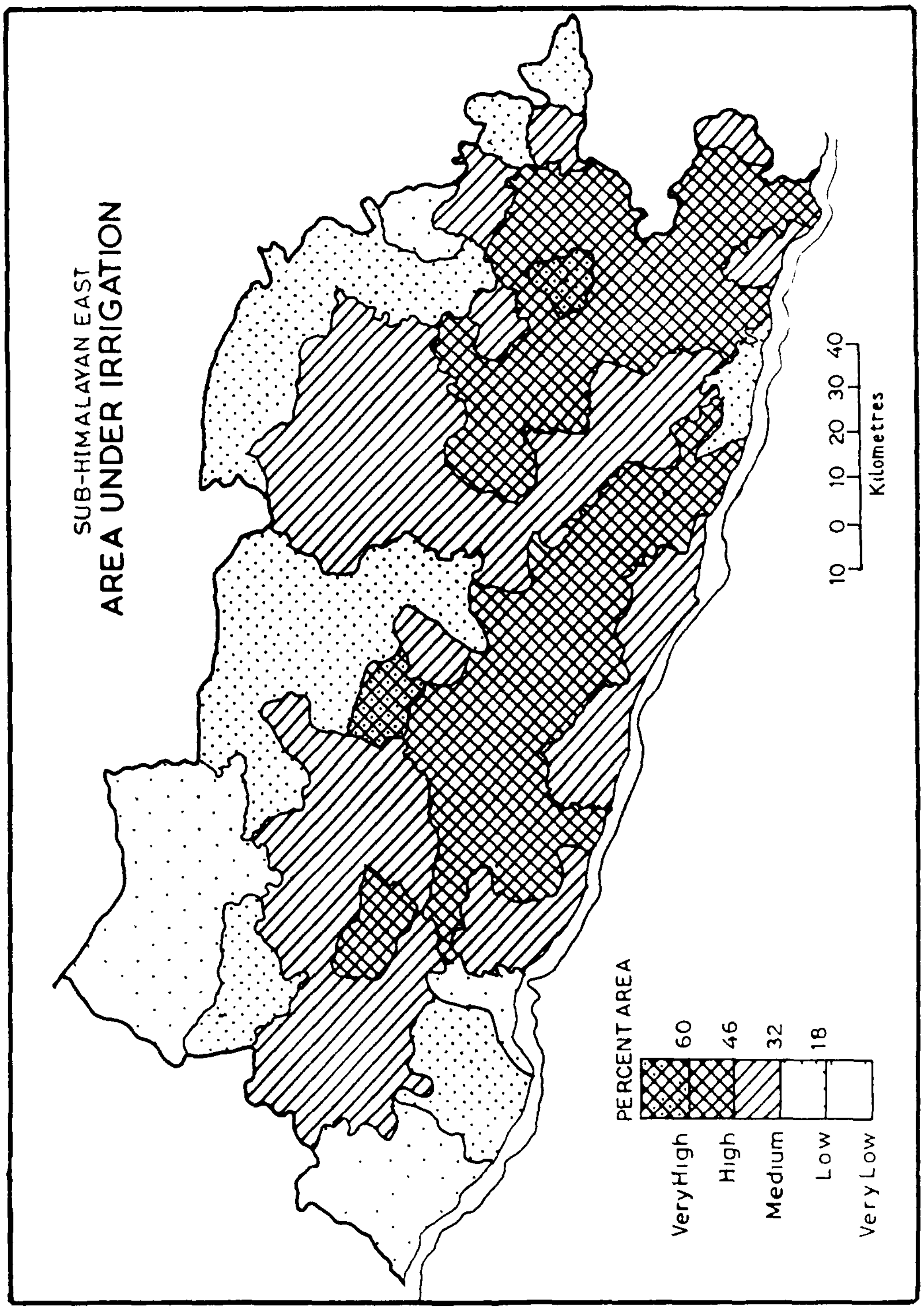
SUB-HIMALAYAN EAST
AREA UNDER IRRIGATION
PERCENT AREA
Very High
High
Medium
Low
Very Low
60
46
32
18
10 0 10 20 30 40
Kilometres

FIG.14

with the pattern of rainfall (Fig.7 and 14). However, the general pattern of irrigation has a marked positive association with the general pattern of the level of agricultural productivity. High yielding varieties of seeds show a close conformity with the spatial pattern of agricultural productivity. It shows a high concentration of area under HYVs in the eastern part which is gradually replaced by medium, low and very low area under HYVs from east to west (Fig.15). Use of chemical fertilizers in kg per hectare (Fig.16) has more or less the same spatial pattern as that of HYVs with the difference that in a small part of western blocks medium level use of fertilizers is found. However, it is clear from Fig.16 that very high, high and medium levels use of chemical fertilizers, strongly associated with the levels of agricultural productivity, are found in the eastern part of the area. There is only one deviation in the patterns of fertilizers use and the levels of agricultural productivity and that is the central part of the area which shows a medium level of agricultural productivity and a low level use of fertilizers.

With minor variations agricultural intensity i.e. proportion of area sown more than once (Fig.17) is in close conformity with general patterns of agricultural

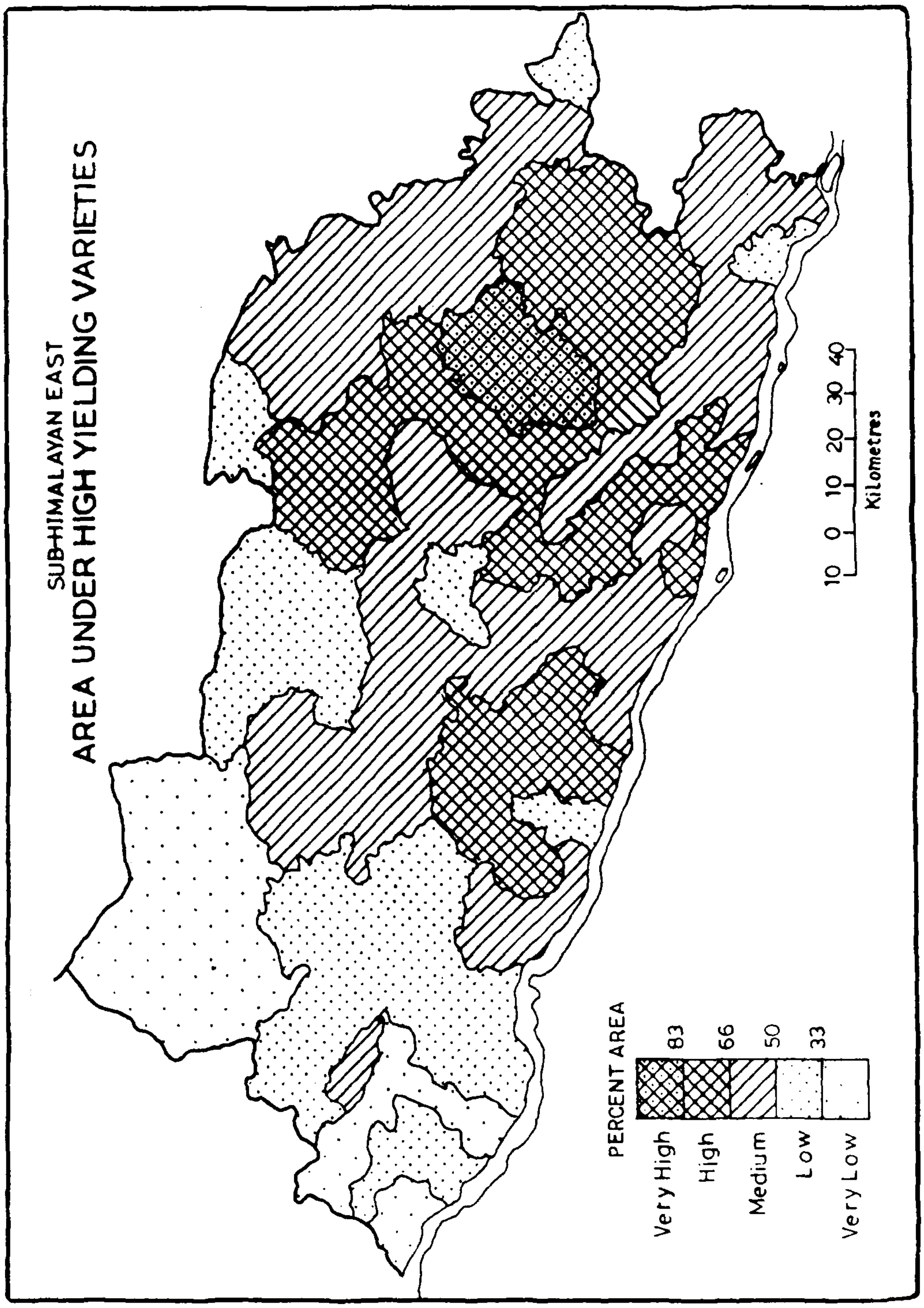
SUB-HIMALAYAN EAST
AREA UNDER HIGH YIELDING VARIETIES
PERCENT AREA
Very High
High
Medium
Low
Very Low
83
66
50
33
10 0 10 20 30 40
Kilometres

FIG.15

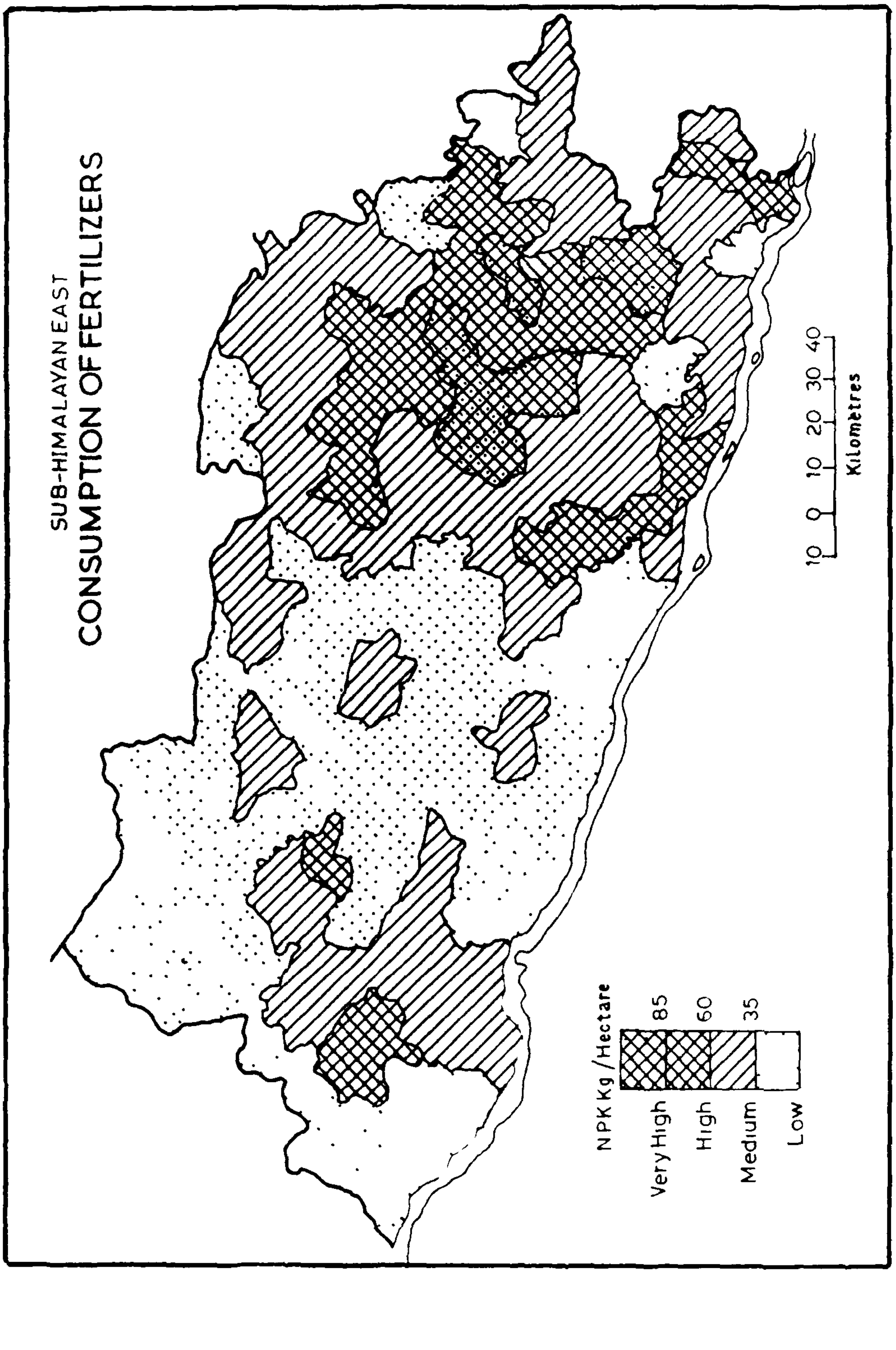
SUB-HIMALAYAN EAST
CONSUMPTION OF FERTILIZERS
NPK Kg/Hectare
Very High
High
Medium
Low
85
60
35
10 0 10 20 30 40
Kilometres

FIG 16

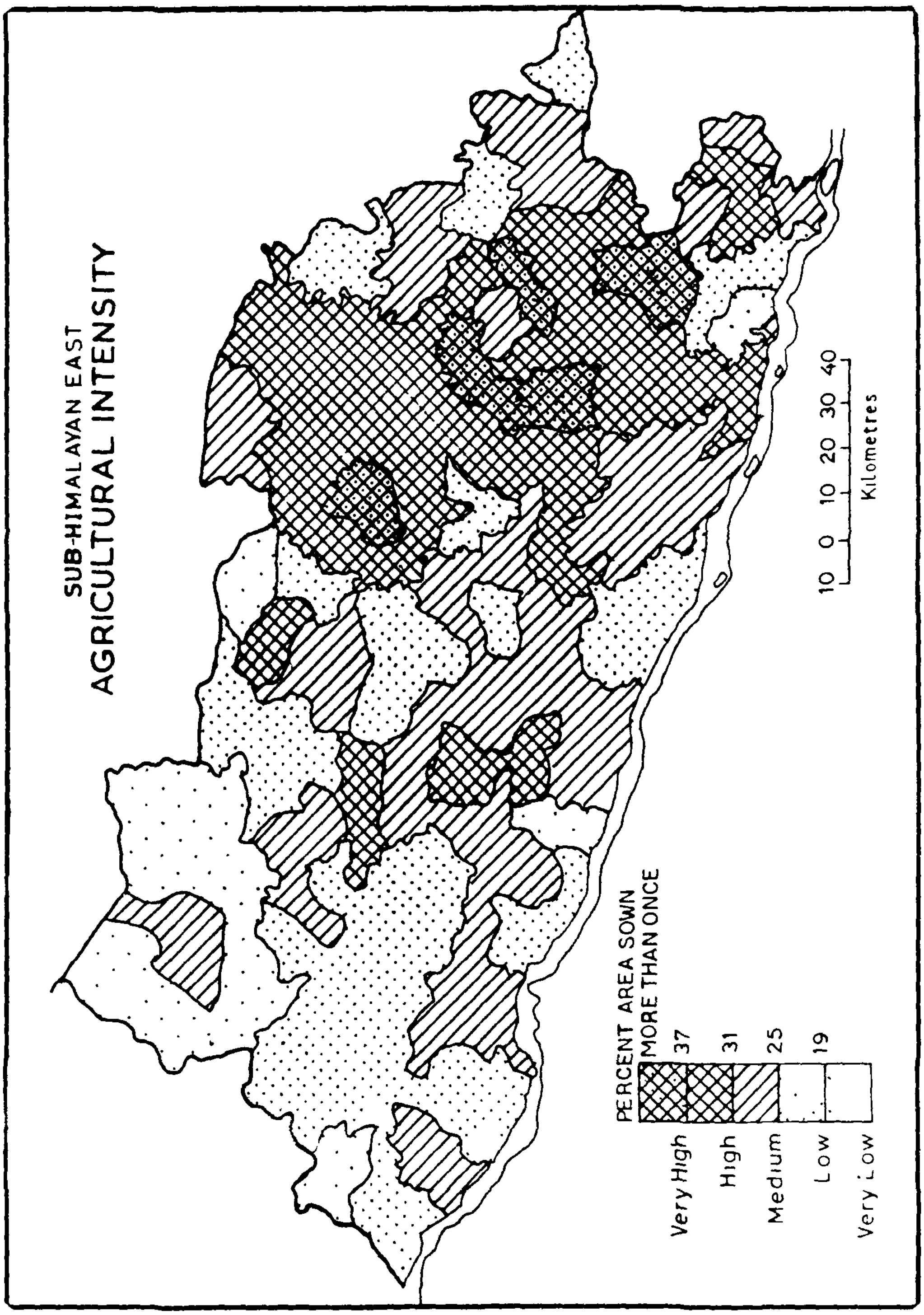
SUB-HIMALAYAN EAST
AGRICULTURAL INTENSITY
PERCENT AREA SOWN MORE THAN ONCE
Very High
37
High
31
Medium
25
Low
19
Very Low
10 0 10 20 30 40
Kilometres

FIG.17

productivity. Very high and high levels of agricultural intensity are found in the region of very high and high agricultural productivity while medium level of agricultural productivity is associated with the medium and low levels of agricultural intensity. The regions of low and very low levels of agricultural productivity are highly associated with the low and very low agricultural intensity.

This examination of possible factors of spatial variation in the levels of agricultural productivity suggests that technological factors are comparatively more strongly associated with the levels of agricultural productivity than the natural factors which have a relatively weak relationship with the levels of agricultural productivity. In fact natural factors are important over a large area where sharp differences in the availability of water and soil characteristics are found. In the area under study, there are spatial variations in the rainfall and soils, but these variations are too small to have a strong bearing on the levels of agricultural productivity. On the contrary small variations in the technological factors bring out large variation in the agricultural productivity. Among them agricultural intensity appears as the strongest factor of variation in agricultural productivity which is followed by HYVs, fertilizers and irrigation. HYVs, fertilizers and irrigation are themsel.es determinants of agricultural intensity. These factors are responsible for the increased yields of crops per hectare and, therefore, the levels of agricultural productivity.

CHAPTER VIII

DIMENSIONS OF REGIONAL DEVELOPMENT

For the analysis of the dimensions of regional development, the technique of factor analysis has been applied selecting twenty variables (Appendix B). These variables are selected keeping in mind the personality of the area and the theoretical constructs of the regional development. These variables fall in the following broad categories: agricultural development; development of urbanization and industrialization; development of infrastructure and amenities and social development. Among these categories agricultural development is indicated by six variables namely multiple cropping, irrigation, fertilizer, high yielding varieties of seeds, tractorization, and tubewells and pump sets. The development of urbanization and industrialization is measured by six variables namely urban population, urban-rural ratio, factories, factory workers, secondary workers and tertiary workers. The development of infrastructure and amenities is indicated by six variables namely road length, road density, banks, electrification, gobar gas plants, and seed and fertilizer storages. Social development is represented by two variables which are literacy rate and schools. In selecting the variables to represent various dimensions of the development, care was taken to select such variables which directly describe the state of development of the areas. The variables are generally measured on ratio scale and in several cases values are reduced to the total population so that the blocks of the region are comparable to each other.

FACTOR STRUCTURE

The factor analysis of 20 variables related to the development of 117 blocks of the region has yielded five major factors which together account for 75.29 per cent of the total variance in the regional development of the Sub-Himalayan East (Table 6). Examination of the rotated factor loadings (Tables 7-11) on these factors rendered them to be labelled as dimensions of agricultural mechanization and infrastructure, institutional development and agricultural intensity, industrialization and education, urbanization and modernization, and infrastructural underdevelopment. As regards the contribution of these factors to the explanation of total variance, it is found that agricultural mechanization and infrastructure explains 17.52 per cent of the total variance, institutional development and agricultural intensity 15.74 per cent,

Table 6

Dimensions of Regional Development in the Sub-Himalayan East

Factors	Per cent of total variance explained
1. Agricultural mechanization and infrastructure	17.52
2. Institutional development and agricultural intensity	15.74
3. Industrialization and education	14.86
4. Urbanization and modernization	14.39
5. Infrastructural underdevelopment	12.78
Per cent of total variance explained by five factors	75.29

industrialization and education 14.86 per cent, urbanization and modernization 14.39 per cent and infrastructural underdevelopment 12.78 per cent of the total variance explained. The first two factors are mostly related to the agricultural development which include more than 33 per cent of the total variance. This mainly highlights the agricultural specialization of the region. Industrialization and education rank third in order while urbanization and modernization rank fourth. Infrastructural underdevelopment is less significant as it takes fifth position. However, interpretation of these factors needs caution as relationships exhibited are complex.

Factor 1: Agricultural Mechanization and Infrastructure

Factor first is closely identified with the agricultural mechanization and infrastructure (Table 7). The nature of this factor is clearly defined by the high loadings of five agricultural variables and two variables of infrastructure. These variables can be regarded as the basic indicants of the agricultural mechanization and infrastructure.

The positive sign of the variables is associated with the higher development of agriculture and infrastructure. Irrigation, high yielding varieties and tractorization all load high and positively on this factor, while fertilizer, tube-wells and pump sets, electrification and storage load moderately on this dimension.

The highest positive loading is shown by irrigation (0.91178) which is followed by tractorization (0.81047). These variables are closely followed by high yielding varieties (0.77970). These positive relationships of agricultural mechanization have further moderate loadings

Table 7

Agricultural Mechanization and Infrastructure

Variable	Factor loading
1. Multiple cropping	0.39044
2. Irrigation	0.91178
3. Fertilizer	0.47511
4. High yielding varieties	0.77970
5. Tractorization	0.81047
6. Tube-wells and pump sets	0.52105
7. Urban population	-0.08065
8. Urban-rural ratio	-0.00364
9. Factories	0.04539
10. Factory workers	0.08137
11. Secondary workers	0.16348
12. Tertiary workers	0.07536
13. Road length	-0.02814
14. Road density	0.25688
15. Banks	0.01534
16. Electrification	0.55024
17. Gobar gas plants	0.23109
18. Seed and fertilizer storages	0.43844
19. Literacy	0.25122
20. Schools	0.17894
Per cent of total variance explained	17.52

with tube-wells and pump sets (0.52105) and fertilizer (0.47511). The relationship among these variables of agricultural development is obvious as the use of high yielding varieties and chemical fertilizer need abundant irrigation. Tractor, in Indian conditions is used both on the farm and off the farm. Association of tractorization with these variables is well understood in the agricultural mechanization of the region.

The positive loadings of electrification (0.55024) and storage (0.43844) reveal the association with agricultural mechanization. Electrification has an important role in the agricultural development of the region. Because farm machinery run by electricity is cheaper than that run on fuel energy. Storage too has positive relationship with agricultural development. Seed and fertilizer stores are found in great numbers in areas where use of high yielding varieties of seeds and fertilizers is more in practice. Thus these two variables of infrastructure are highly associated with agricultural mechanization.

Louis Malassis emphasises the role of agricultural mechanization in the process of development: 'Agricultural progress has mainly taken the form of improvement of plant and animal species, the discovery of high-yielding varieties, fertilizer technology, plant protection, water technology,etc.'[1]

Mechanization constitutes an essential ingredient of modern agriculture. Increasing use of specialized modern agricultural tools and implements in keeping with the indigenous environment is an inseparable part of the process of modernizing agriculture. Mechanization facilitates the substitution of capital for labour which raises efficiency and productivity, which in turn reduces the cost of agricultural production and raises the incomes of the farmers.[2] Tractorization is the most common form of the mechanization of agriculture. Use of tractors raises both the yield per hectare and cropping intensity. Their use in the conditions of shortages, rising prices of agricultural commodities and the rising cost of human and animal labour is of high social value. In this factor tractorization has high positive association with

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1 Malassis, L., 'Agriculture and the Development Process; tentative guidelines for teaching', Education and Rural Development, 3, Unesco, Paris, 1975, pp.197-8.

2 Hanumantha Rao, C.H., 'Farm Mechanization in a Labour Abundant Economy,'Economic and Political Weekly, Annual No.1972, Vol.3, Nos.5-7.

tube-wells and pump sets that also lead to an increase in the cropping intensity and yield per hectare which alter the place of agricultural development and raise the farmer's income.

Agriculture and the economy as a whole and rural communities and society as a whole, are interdependent: agriculture often plays a decisive role in economic 'take-off' but overall economic growth in turn brings about important changes in the agricultural economy - by increasing monetary demand for foodstuffs, creating non-agricultural employment requiring a transfer of manpower from the countryside to the towns and creating demand for producer and consumer goods in the agricultural sector, whose purchasing power tends to increase. Analysis of the process of development therefore places considerable emphasis on the relationships between agriculture and industry. In pre-industrial societies where almost the whole population earns its living from the land, the type of farming engaged in is necessarily subsistence farming; during the process of overall development, agriculture becomes more market-orientated; in fully industrialised economies agriculture itself tends to become industrialised, that is to say, to adopt the methods and structures of the industrial economy.[3]

Fig.18 shows the spatial dimension of agricultural mechanization and infrastructure in the Sub-Himalayan East. The high positive factor scores on this factor imply irrigation, tractorization, high yielding varieties, tube-wells and pump sets, fertilizer, electrification and storage. These high factor scores can be identified with the high level of agricultural mechanization and infrastructure.

The standardised factor scores have been divided into five grades (class intervals) of very high, high, medium, low and very low. The very high factor scores are more than +1.5 standard deviation from the mean (0.0). The category of high mechanization and infrastructure ranges from +0.5 to +1.5 standard deviation. The medium grade of the factor scores ranges from -0.5 to +0.5 standard deviation. The factor scores ranging from -0.5 to -1.5 standard deviation are categorized in the low grade

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3 Malassis, L., The Rural World: Education and Development, Unesco, Paris, 1976, p.55.

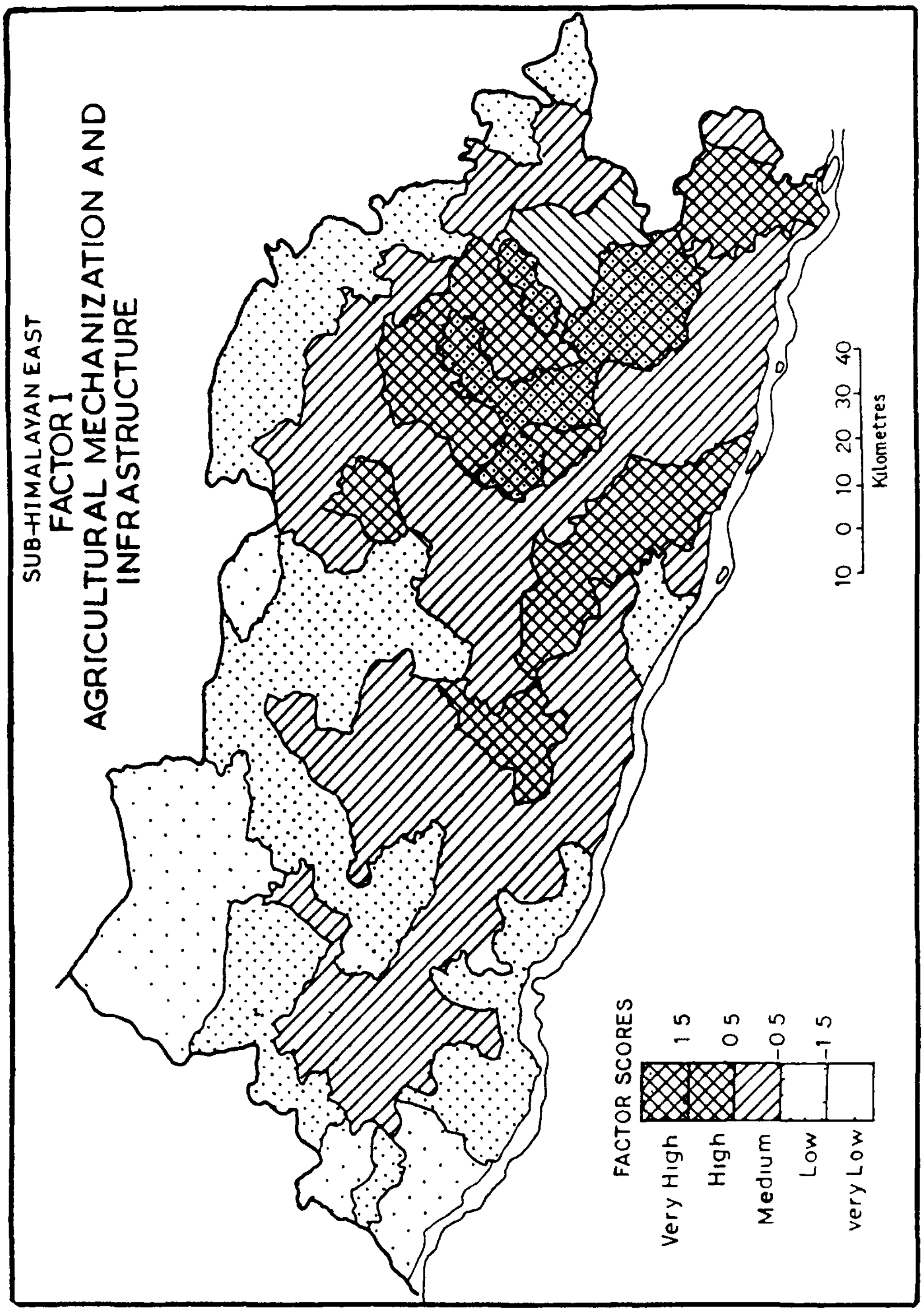
SUB-HIMALAYAN EAST
FACTOR I
AGRICULTURAL MECHANIZATION AND INFRASTRUCTURE
FACTOR SCORES
Very High
High
Medium
Low
very Low
1 5
0 5
-0 5
-1 5
10 0 10 20 30 40
Kilometres

FIG 18

of mechanization and infrastructure. Blocks showing factor scores less than -1.5 standard deviation are grouped in the class of very low agricultural mechanization and infrastructure. The areas of very high factor scores are concentrated in the eastern part of the region. They constitute a contiguous region extending over the blocks Chargawan, Captainganj, Pipraich, Sardarnagar , Gauri Bazar, Baitalpur, Deoria and Rampur Karkhana (Fig.18 and Appendix C). Another block of the same grade is Hata which lies in the east of the main region. It is highly interesting to note that the blocks of very high factor scores, except Baitalpur, have urban centres with their varying sizes. Besides, they are well linked by transport networks. It is, therefore, obvious that these blocks are characterised by very high agricultural mechanization and infrastructure. The high factor scores are concentrated in the eastern half of the region forming four regions. The first region of the high factor scores lies adjacent to the very high region in the northeast. This region includes the blocks of Bhathat, Pertawal, Ghughli, Ramkola, Motichak, Sukrauli, Desai Deoria, Kasia and Patherdewa. Second region of high factor scores is situated in the southcentral part comprising the blocks of Khalilabad, Sahjanwa, Khazni, Urwa, Bansgaon and Gola. The third compact region in the extreme southeast is composed of four blocks namely Bhatni, Bhatpar, Lar and Salempur. Two blocks (Basti and Saonghat) of the same grade constitute a fourth region in the southcentral part of the Basti district. The areas having medium factor scores are scattered allover the region. However, they constitute fairly big but irregular regions. One such region spreads over the eastern part, encircling the very high and high regions, consisting of Bhagalpur, Barhaj, Bhaluani, Barhalganj, Gagaha, Rudrapur, Kauri Ram, Bramhpur, Piprauli, Pali, Semariawan , Baghauli, Menhdawal, Jangal Kauria, Compierganj, Paniara , Maharajganj, Brijmanganj, Lakshmipur, Mithaura, Siswa, Nebua Naurangia, Padrauna, Fazilnagar and Tamkuhi blocks. Another region spreads over the central part of the Gonda district and southern part of the Basti district. This region includes Jhanjhari, Pandari Kirpal, Itiathok, Mujehana, Utraula, Wazirganj, Mankapur, Chhapia, Parasrampur, Harraiya, Captainganj, Bahadurpur, Kudraha, Bankati, Nathnagar, Gaur, Saltauwa, Rudhauli, Mithwal, Ramnagar, Domariaganj and Khuniaon blocks.

The areas of low factor scores are scattered in the periphery of the region. They form a contiguous region in the northeastern periphery consisting the blocks of

Nautanwa, Nichlaul, Khadda and Bishunpura. Another region of low factor scores is situated in the northcentral part of the region including the blocks of Gendas Buzurg, Rehra Bazar, Babhanjot, Bhanwapur, Itwa, Barhni, Naugarh, Jogia, Bansi, Uska, Khesraha, Dhani and Santha. Third region of the same grade lies in the southwestern periphery comprising the blocks of Belsar, Tarabganj, Nawabganj and Bikramjote. Rupaidih, Balrampur and Shridattganj blocks also fall in the same grade forming a separate region in the westcentral part of the Gonda district. The areas of very low factor scores form a compact region in the northern part of the Gonda district constituting the blocks of Haraiya Satgharwa, Tulsipur, Gainsari and Pachperwa. Other blocks of the same grade fail to constitute sizable regions.

Factor 2 : Institutional Development and Agricultural Intensity

This is the second most important factor explaining 15.74 per cent of the total variance. It is closely related with the variables of banks, gobar gas plants, tertiary workers, multiple cropping and fertilizers (Table 8). These relationships suggest that this is the dimension of institutional development and agricultural intensity. The rotated factor shows that the highest

Table 8

Institutional Development and Agricultural Intensity

	Variable	Factor loading
1.	Multiple cropping	0.72314
2.	Irrigation	0.09528
3.	Fertilizers	0.57006
4.	High yielding varieties	0.39358
5.	Tractorization	0.13812
6.	Tubewells and pump sets	0.27423
7.	Urban population	0.07585
8.	Urban-rural ratio	0.03300
9.	Factories	0.14785
10.	Factory workers	0.14500
11.	Secondary workers	0.16542
12.	Tertiary workers	0.43931
13.	Road length	0.17691
14.	Road density	0.30639
15.	Banks	0.87500
16.	Electrification	0.03227
17.	Gobar gas plants	0.86927
18.	Seed and fertilizer storages	0.21409
19.	Literacy	0.25013
20.	Schools	0.12268
	Per cent of total variance explained	15.74

loading is by banks (0.87500) which is followed by gobar gas plants (0.86927). Multiple cropping (0.72314) also load high on this factor. In addition to these fertilizers (0.57006) and tertiary workers (0.43931) load moderate positively on this factor. All these loadings are remarkably consistent in their sign.

The positive sign of the variables indicate higher institutional development and agricultural intensity. The association of banks with the variables of gobar gas plants, tertiary workers, double cropping and fertilizers is well understood. Bank establishments are found in areas that are more productive and economically well-off. Datt and Sundharam point out the importance of banks in Indian agriculture[4]. Majority of the Indian farmers need finance not only for production purposes but also for consumption purposes. Traditionally the farmers are accustomed to spend beyond their means, on births and deaths, on marriages and other social and religious occasions. However, the establishment of regional rural banks in an agricultural area is a step forward in the developing economies. The main objective of the regional rural banks is to provide credit and other facilities particularly to

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4 Datt, R. and Sundharam, K.P.M., Development Issues of the Indian Economy, New Delhi, 1979, p.196.

the small and marginal farmers, agricultural labourers, artisans and small entrepreneurs so as to develop agriculture, trade, commerce, industry and other product activities in the rural areas. Thus rural banks have an important role to play in the rural economy as they have to act as alternative agencies to provide institutional credit in rural areas.

Productivity of land can be explained by the positive relationships of the variables of multiple cropping and fertilizers. The employment of tertiary workers is again high in areas of bank establishments. Besides, it is associated with the gobar gas plants. The establishment of these plants is related to bank facilities. The government provides incentives to farmers wishing to establish gobar gas plants. These plants are treated as status symbol in the village life. They provide fuel and light and play a role in the development of the villages. Thus the institutional development and agricultural intensity is the most important dimension in the regional development of the Sub-Himalayan East.

Fig.19 shows the spatial differentiation of institutional development and agricultural intensity in the Sub-Himalayan East. The areas of very high factor

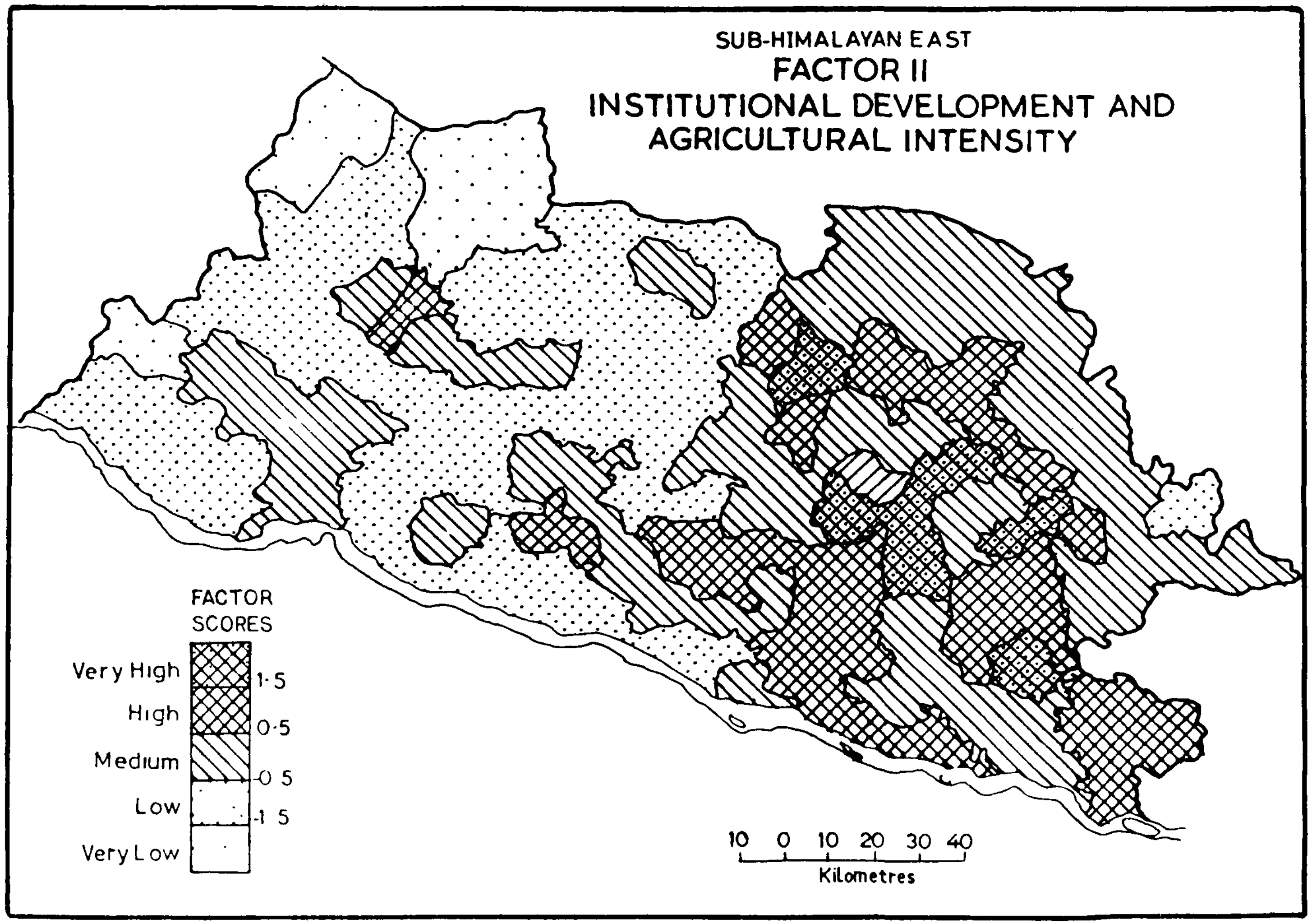
SUB-HIMALAYAN EAST
FACTOR II
INSTITUTIONAL DEVELOPMENT AND
AGRICULTURAL INTENSITY
FACTOR SCORES
Very High
High
Medium
Low
Very Low
1·5
0·5
-0 5
-1 5
10 0 10 20 30 40
Kilometres

FIG 19

scores form a compact region in the eastern part of the region including the blocks of Chargawan, Pipraich, Sardarnagar and Captainganj. Apart from this, three blocks (Pharenda, Hata and Deoria) of the same grade are scattered in nature. Four regions of high factor scores lie around the areas of very high factor scores, at places, separated by medium factor scores. First region lying contiguous to the west of the very high region spreads over Khalilabad, Sahjanwa, Piprauli, Khorabar, Urwa, Bansgaon, Kauri Ram, Gola and Barhalganj. Second region which lies in the southeast of the very high region comprises the blocks of Gauri Bazar, Baitalpur, Desai Deoria and Rampur Karkhana. Third region forms a compact region in the southeastern part of the region extending over Bhatni, Salempur, Lar, Bhatpar and Bankata blocks. Fourth region lies north of the very high region including the blocks of Maharajganj, Siswa, Ghughuli and Ramkola. The areas of medium factor scores are well distributed allover the region. They form a continuous belt in northwest-southeast direction in the northern part of the region. The blocks of this region are Lakshmipur, Nautanwa, Mithaura, Nichalaul, Khadda, Nebua Naurangia, Bishunpura, Padrauna, Pathardewa, Fazilnagar, Tamkuhi and Siwarhi. Another region of the same grade spreads over central

Gorakhpur comprising blocks Paniara, Partawal, Jangal Kauria, Pali, Menhdawal and Dhani. Third region lies in the southeastern part between two regions of high factor scores and includes the blocks of Brahmpur, Rudrapur, Gagaha, Barhaj, Bhaluani and Bhagalpur. A fourth region of medium factor scores is concentrated in the southeastern part of the Gonda district comprising the blocks Jhanjhari, Pandari Kirpal, Wazirganj, Mankapur and Nawabganj. Five blocks of the same grade form a narrow belt in the central part of the region. They are Saltauwa, Saonghat, Bankati, Nathnagar and Khazni. The western part of the Sub-Himalayan East is mainly occupied by low factor scores. A big region of this grade extends over Gonda and Basti districts separated by medium and high factor scores at places. This region includes 30 blocks which accounts for 25.6 per cent of the total blocks of the region. Apart from this a small region of the same grade lies in the southern part of the Gonda district comprising blocks Haldhar Mau, Colonelganj, Paraspur, Belsar and Tarabganj. Two blocks (Gainsari and Pachperwa) having very low factor scores form a distinct region in the northeastern part of the Gonda district.

Factor 3 : Industrialization and Education

Factor 3 is strongly related to the measures of factories, factory workers, secondary workers and schools (Table 9). This dimension of industrialization and education represents another component of regional development. The factories of the region are agro-based and majority of them are sugar factories. They are located in cities, towns and rurban centres where educational status is high in comparison to rural areas, characterizing strong positive association with the variables of this factor.

The highest positive loading on this factor is registered by secondary workers (0.86432). This is followed by an almost equally high and positive loadings by schools (0.85006) and factory workers (0.83505). The next high and positive loading is shown by factories (0.63262). On the basis of strong relationships of these variables this factor can be designated as the dimension of industrialization and education.

Industrialization has a major role to play in the regional development of the underdeveloped regions. The gap in per capita incomes between the developed and underdeveloped countries is largely reflected in the disparity

Table 9

Industrialization and Education

	Variable	Factor loading
1.	Multiple cropping	0.16653
2.	Irrigation	0.02104
3.	Fertilizers	0.15110
4.	High yielding varieties	0.10228
5.	Tractorization	0.17485
6.	Tubewells and pump sets	0.06928
7.	Urban population	0.24824
8.	Urban-rural ratio	0.19921
9.	Factories	0.63262
10.	Factory workers	0.83505
11.	Secondary workers	0.86432
12.	Tertiary workers	0.23792
13.	Road length	0.10590
14.	Road density	0.17171
15.	Banks	0.07357
16.	Electrification	0.20876
17.	Gobar gas plant	0.11663
18.	Seed and fertilizer storages	0.08654
19.	Literacy	0.19836
20.	Schools	0.85006
	Per cent of total variance explained	14.86

in the structure of their economies; the former are largely industrial economies, while in the latter, production is confined predominantly to agriculture.[5] Furthermore, the growth of modern industry provides employment for an underutilized labour force bottled up in agriculture. Industrialization is held to be crucial to development strategy because it radiates stimuli throughout the economy and lift it out of stagnation.[6]

Education amongst illetracy in Indian conditions has a high social value. Schools are lacking and sub-standard. The high positive loading of schools on industrial variables reveal that the industrial areas have more schools than other areas. Education is a necessary organ for the development of a society. It is the basis of the creation-dissemination system that triggers technical progress, which is the main component of economic growth and increased productivity of labour. Thus there is a dialectical relationship between education and society: social development and educational development are inseparable.

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5 Datt and Sundharam, op. cit., p.261.

6 Myrdal, G., Asian Drama: An Inquiry into the Poverty of Nations, Abridged Volume, Penguin Books, London, 1972, p.248.

The spatial patterns of industrialization and education are shown in Fig.20. Factor scores mapped show the nature of secondary workers, factories, factory workers and schools. Five blocks (Chargawan, Pipraich, Sardarnagar, Captainganj and Ramkola) forming a contiguous area in the eastern part of the region are characterized by very high factor scores. A small pocket of very high factor scores lies in the central part including the blocks of Khalilabad and Sahjanwa. Besides, another small pocket of the same grade constituting two blocks (Deoria and Bhatni) lies in southeastern part. The remaining two blocks of high factor scores fail to constitute any region. East of the main region of very high factor scores lie two small regions of high factor scores. One region in the north includes Hata, Kasia and Padrauna blocks while another lying in the south includes the blocks of Gauri Bazar and Baitalpur. The areas of medium factor scores are spread allover the region with their main concentration in southern and eastern part of the region. A fairly big region spreads over the southern part extending from the central part of the Basti district to the southeastern part of Deoria. This region includes twenty six blocks. Five blocks (Rupaidih, Balrampur, Shridattaganj, Utraula and Tulsipur) of the same grade make a distinct region in

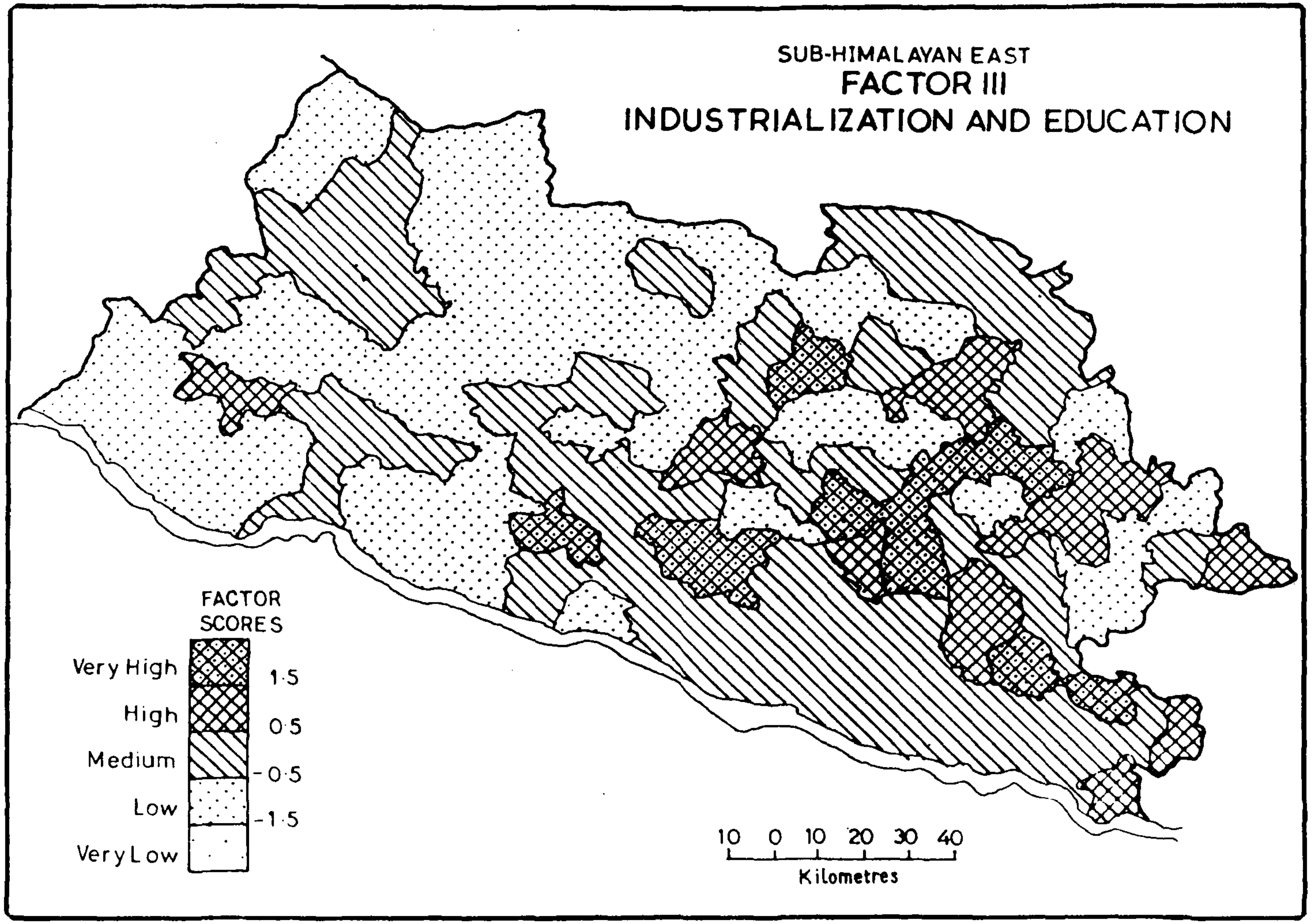
SUB-HIMALAYAN EAST
FACTOR III
INDUSTRIALIZATION AND EDUCATION
FACTOR SCORES
Very High
High
Medium
Low
Very Low
1·5
0·5
-0·5
-1·5
10 0 10 20 30 40
Kilometres

FIG.20

the northwestern part of the Gonda district. Another region of the same grade forms a belt in the northeastern part of the region constituting the blocks of Nautanwa, Nichlaul, Khadda and Nebua Naurangia. Three blocks (Nawabganj, Mankapur and Chhapia) of medium factor scores make a distinct region in the southeastern part of the Gonda district. The areas of low factor scores are mainly concentrated in the western part of the region. They form an irregular region including 34 blocks of the Sub-Himalayan East. A small region of the same grade lies in the eastern part of Deoria district comprising the blocks of Pathardewa, Fazilnagar and Dudhai. Besides, a small pocket of three blocks (Compierganj, Paniara and Partawal) form a distinct region in the central part of Gorakhpur district.

Factor 4 : Urbanization and Modernization

Factor 4 is the next important dimension of regional development of the Sub-Himalayan East. Urban-rural ratio and urban population denote urbanization while literacy and tube-wells and pump sets are the sign of modernization. Table 10 shows the loadings on this factor. Urban-rural ratio load highest (0.89779) followed by urban population (0.87253). Literacy has also high

Table 10

Urbanization and Modernization

	Variables	Factor loading
1.	Multiple cropping	0.00799
2.	Irrigation	0.06909
3.	Fertilizers	0.13703
4.	High yielding varieties	-0.07932
5.	Tractorization	-0.08726
6.	Tube-wells and pump sets	0.44869
7.	Urban population	0.87253
8.	Urban-rural ratio	0.89779
9.	Factories	0.35512
10.	Factory workers	-0.02868
11.	Secondary workers	0.28806
12.	Tertiary workers	0.05985
13.	Road length	0.15286
14.	Road density	0.26846
15.	Banks	0.14152
16.	Electrification	0.25877
17.	Gobar gas plants	0.17731
18.	Seed and fertilizer storages	0.00113
19.	Literacy	0.73976
20.	Schools	0.31308
	Per cent of total variance explained	14.39

positive loading (0.73976). Tube-wells and pump sets load moderately (0.44869) on this factor. Urbanization and modernization go side by side. Urban population has strong positive association with literacy. This clearly indicates a higher percentage of literacy in urban areas than in the rural areas.

Literacy is a sign of modernization amongst mass illeteracy in India. Tube-wells and pump sets load positively on this dimension. This relationship indicates urban influence on adjoining rural areas of the blocks. Firstly the irrigation system requires technical know-how which can be easily met in urban areas. Secondly tube-wells consume electricity. The electrification around urban areas is more than in other areas. Thirdly, a handsome proportion of population of urban workers and servicemen live in villages near the urban centres. Therefore tube-wells and pump sets have positive relationship with urbanization.

Level of urbanization is also considered to be an indicator of development. Sharma[7] (1972) established

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7 Sharma, N., Degree of Urbanization and Level of Economic Development in Chotanagpur: A Study in Nature of Relationship, Indian Journal of Regional Science, Vol.IV, No.2, 1972, pp.143-154.

relationship between degree of urbanization and level of economic development in Chotanagpur by telescoping the effect of urbanization in the perspective of industrial development, creation of sectoral employment, generation of sectoral income and that of per capita income. He found that urbanization and per capita income have perfect positive correlation.

In an underdeveloped country with a traditional social structure, which is going through a process of socio-economic change under conditions of political democracy, free migration of population has wider economic, political and cultural aspects. This internal migration induced by small, isolated pockets of prosperity in a country in which basic development is extremely uneven in spatial terms, has the perverse effect of accentuating regional inequality. There is overwhelming evidence that the countryside expels not necessarily the most efficient and enterprising workers, but vast masses of landless peasants and marginal farmers who fall below the margin and are unable or unwilling to carry on as floating labourers in the rural areas. When they flock to the cities they create a perverse type of urbanization, which has by now become a dangerous potent of economic, social and political instability. Thus the emergence of such cities, towns and growth centres have their own socio-economic and regional characteristics. No doubt urbanization brings change in developmental processes but at the same time it brings regional instability too.[8]

The spatial pattern of urbanization and modernization is shown in Fig.21. The high factor scores on this dimension mean a high rate of urbanization and modernization. An examination of the map reveals a random distribution of very high and high levels, thereby signifying the randomness of the distribution of the urban centres in the region. A small pocket of very high urbanisation and modernization lies in the central part of the Gorakhpur district constituting the blocks of Chargawan, Pipraich and Sardarnagar. Other blocks of the very high grade are scattered in nature and fail to make any region. The areas of high factor scores constitute small pockets. One such pocket is situated in the northeast of very high region including the blocks of Captainganj, Ramkola and Padrauna. Another pocket lying west of very high region comprises

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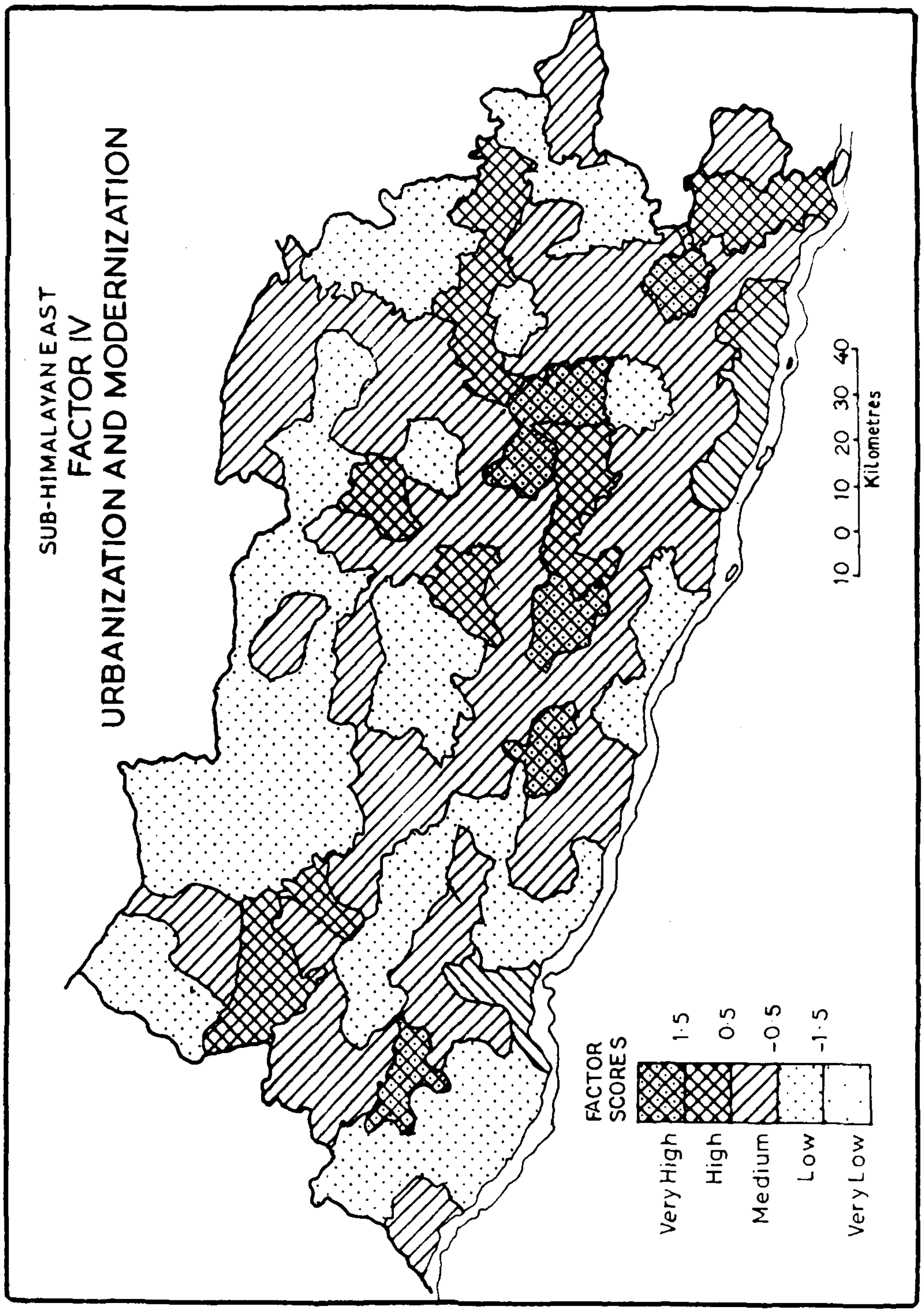
8 Ganguli, B.N., Population and Development, New Delhi, 1973, pp.54-59.



SUB-HIMALAYAN EAST
FACTOR IV
URBANIZATION AND MODERNIZATION
FACTOR SCORES
Very High
High
Medium
Low
Very Low
1·5
0·5
-0·5
-1·5
10 0 10 20 30 40
Kilometres

FIG.21

three blocks of Sahjanwa, Piprauli and Khorabar. Third pocket of this grade lies in the southeast along the river Ghaghara including the blocks of Gola, Barhalganj and Barhaj. Fourth pocket lies in southeastern part of Deoria district spreading over Bhatni, Salempur and Lar blocks. Five blocks of the high factor scores fail to constitute any identifiable region. An interesting point to note is that all the blocks, having very high and high factor scores either have urban centres or show the influence of Gorakhpur city. The areas of medium factor scores show an irregular distribution. They form a narrow belt in the southern part of the region extending from west to east. Another narrow belt is found in the central part of Basti district, which enters in Gorakhpur district in the central part and extending further east and north of the district forms a circular belt around low factor scores in the northern part. The concentration of the low factor scores is found in the northern and western part of the region.

Factor 5 : Infrastructural Underdevelopment

This factor has unique qualities in comparison to previous factors. The significant loadings of this factor are in negative whereas the significant loadings of the previous factors have positive signs. Owing to its negative loadings in infrastructural variables, this factor can be called as infrastructural underdevelopment. The loading of this factor is given in Table 11. The highest negative loading is shown by road length (-0.87063) followed by road density (-0.75755) and storage (-0.68476).

The development of a region depends upon the development of agriculture and industry, but then such a development cannot take place without the simultaneous development of infrastructure. The rural areas of India are stagnant and lagging behind the urban areas because the infrastructure in them is inadequate and of inferior quality. Hence it has failed to weave the agricultural regions with the industrial, to the extent desirable, and has rendered it difficult for them to share more fully the general economic advance. For example, rural electrification has recorded a limited and limping progress and has not so far opend up new possibilities of regional development. Likewise, the general and vocational educational base has expanded insufficiently and as such has not made any evident contribution to the development of the rural areas. This is a conclusion at which the farmers of the Third Five Year Plan arrived at.[9] Moreover, the infrastructural

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9 Government of India, Planning Commission, <u>Third Five Year Plan</u>, New Delhi, 1961.

Table 11

Infrastructural Underdevelopment

	Variable	Factor loading
1.	Multiple cropping	-0.21463
2.	Irrigation	0.00224
3.	Fertilizers	-0.38442
4.	High yielding varieties	-0.08322
5.	Tractorization	-0.36478
6.	Tube-wells and pump sets	0.17140
7.	Urban population	-0.21919
8.	Urban-rural ratio	-0.08712
9.	Factories	-0.29631
10.	Factory workers	-0.27559
11.	Secondary workers	0.04714
12.	Tertiary workers	-0.24496
13.	Road length	-0.87063
14.	Road density	-0.75755
15.	Banks	-0.19617
16.	Electrification	-0.23739
17.	Gobar gas plants	-0.03106
18.	Seed and fertilizer storages	-0.68476
19.	Literacy	-0.11785
20.	Schools	0.02016
	Per cent of total variance explained	12.78

facilities will produce results only when other investments follow suit and other activities are stimulated, and the 'economies of linked development' are reaped.[10] Myrdal points out that social overheads are deficient in the agricultural regions also because the spread effects of industrialization have been weaker than its backwash effects.[11] The infrastructural facilities are lacking in the Sub-Himalayan East in comparison to other components of regional development. This fact is reflected in the negative loadings of road length, road density and storage.

Fig.22 shows the spatial patterns of infrastructural underdevelopment in the Sub-Himalayan East. The high positive factor scores on this factor imply low proportion of road length, road density and storage facilities. On the contrary high negative factor scores imply relatively high proportion of road length, road density and storage facilities. Thus the high negative factor scores can be identified with the high level of infrastructural development.

As shown in Fig.22 the high factor scores (i.e. low infrastructural development) are concentrated in the

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10 Mandelbaum, K., <u>The Industrialization of Backward Areas</u>, Oxford, 1955, p.viii.

11 Myrdal, G., <u>Rich Lands and Poor</u>, New York, 1957, pp.27-31.

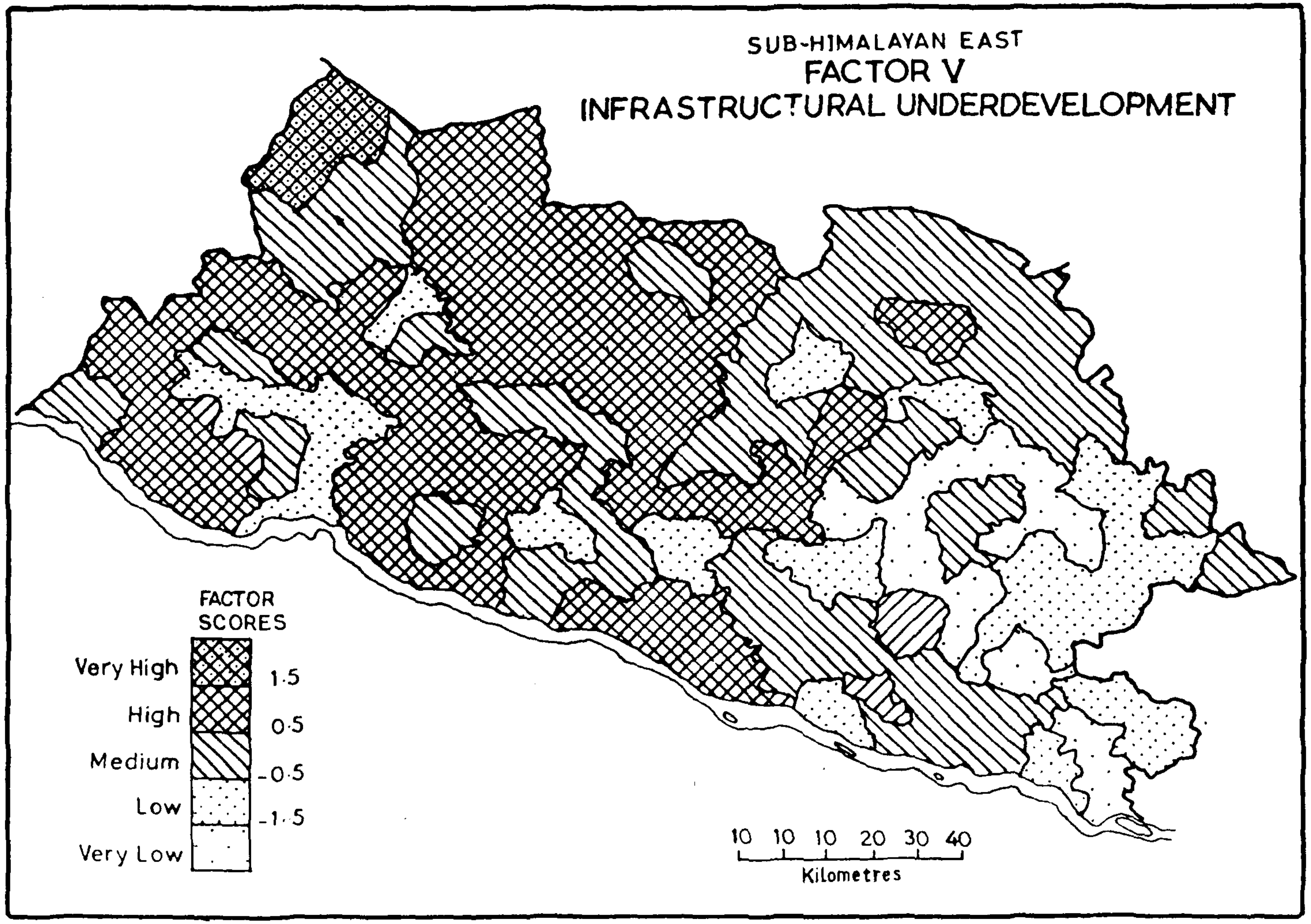
SUB-HIMALAYAN EAST
FACTOR V
INFRASTRUCTURAL UNDERDEVELOPMENT
FACTOR SCORES
Very High
High
Medium
Low
Very Low
1·5
0·5
-0·5
-1·5
10 10 10 20 30 40
Kilometres

FIG 22

west covering a large part of the region. They form an irregular region partly interrupted by the areas of low and medium factor scores. Medium factor scores (i.e. moderate infrastructural development) spreads over the eastern part around the region of low and very low factor scores. The low and very low factor scores (i.e. high infrastructural development) make a contiguous region in the eastern part of the region. These eastern blocks are more developed as they have more infrastructural facilities and higher proportion of urban population.

CHAPTER IX

AGRICULTURAL PRODUCTIVITY AND REGIONAL DEVELOPMENT

After examining the regional patterns of agricultural productivity and dimensions of regional development in the study area, it would be worthwhile to study the levels of development in relation to agricultural productivity.

Regional development has been interpreted as intra-regional development designed to legitimately reduce disparities in development through planning. However, before planning, the regions lagging behind are to be demarcated and components of development are to be analysed.

However, agriculture in India through its multifareous relationships has bearing on the industrial, urban, technological and social development. Agriculture itself is a system composed of multiple components and productivity measures the efficiency of the entire agricultural system. Therefore, level of agricultural productivity can safely be relied upon as a measure of development in agriculture.

Agriculture can contribute significantly to overall development as it provides increased food surplus to the growing population, helps to expand the secondary and tertiary sectors, increases rural incomes and improves the welfare of the rural population of the region. Furthermore, agriculture can contribute to overall development in five ways:

1. By increasing the volume of agricultural production in proportion with the growth in internal and external demands;

2. By the transfer of resources, labour and capital from agriculture to other sectors of the economy, thus contributing to overall growth if the productivity of the factors transferred is higher outside the agricultural sector than within it;

3. By contributing to the supply of foreign exchange and to the balance of payments, to the extent that exports of agricultural products exceed imports. The foreign currency obtained from net exports can be used to import the capital goods needed to modernize the economy;

4. By contributing to the process of industrialization either through supplying raw materials for the agricultural industries or through purchasing industrial goods, thus

stimulating the process of industrialization and overall growth.[1] Rising agricultural productivity supports and sustains industrial development in several important ways: Firstly, it permits agriculture to release part of its labour force for industrial employment while meeting the increasing food needs of the non-agricultural sector. Secondly, it raises agricultural incomes, thereby creating the rural purchasing power needed to buy the new industrial goods and rural savings which may then be mobilized, by direct or indirect means, to finance industrial development. Finally, it enables agriculture to supply the major wage good (food) of industrial workers at prices favourable to the profitability of new industry.[2]

5. Agricultural development also brings about social and cultural development as increased per capita income in rural areas invariably results in increased literacy and level of education which are condusive for social transformation.[3]

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1 Malassis, L., The Rural World, London, 1976, pp.55-56.

2 Lewis, W.A., Theory of Economic Growth, London, 1955, p.334.

3 Malassis, L., op. cit., p.20 and p.41.

It is clear that, under all circumstances, increasing agricultural productivity makes important contributions to regional development and that, within considerable limits at least, it is one of the pre-conditions which must be established before a take-off into self sustained economic growth becomes possible. It is equally clear that social and cultural change necessary to assimilate new industrial and technological development is possible through increased agricultural production.

The principal objective of this chapter is to find out empirically as to what extent this theoretically postulated relationship between agricultural productivity and levels of development holds true in the case of the area under study. It would be worthwhile to test this hypothesis and to find out whether or not the high agricultural productivity regions of the Sub-Himalayan East of Uttar Pradesh are well developed regions. A comparative study of agricultural productivity and levels of development will give significant results. For the purpose of this study composite indices of agricultural productivity and levels of development are constructed. The regional patterns of agricultural productivity and levels of development are described in the following sections and their relationship is analysed in the last section.

COMPOSITE INDEX OF AGRICULTURAL PRODUCTIVITY

Computational Procedure

Regional patterns of the agricultural productivity in the Sub-Himalayan East have been examined by combining five different indices of agricultural productivity. These indices show more or less similar pattern of the agricultural productivity in the area. However, these indices connote different concepts. Therefore, it is decided to examine regional patterns of agricultural productivity such that all these concepts are combined together. This means that an aggregate index of agricultural productivity should be calculated with proper weightage to each index. The solution is seen in factor analysis. The five indices are subjected to the factor analysis and only one factor is extracted. This factor (Table 12) exhibits high positive loadings of these indices. None showing a loading less than 0.8.

The total variance explained by this factor is 81.86. Therefore, this factor can safely be taken as the dimension of agricultural productivity. The loadings of different indices on this factor are treated as their weights on the agricultural productivity. These indices

Table 12

Factor Loadings of Productivity Indices

	Index	Factor loading
1.	Standard nutrition unit per hectare	0.92756
2.	Agricultural output per hectare	0.90540
3.	Agricultural output per agricultural worker	0.84333
4.	Bhatia's productivity index	0.94130
5.	Shafi's productivity coefficient index	0.90306
	Per cent total variance explained	81.86

are standardized and multiplied by their respective loadings. Then these are added together to give factor scores on this dimension of agricultural productivity. These scores are further standardized to zero mean and unit variance for comparability with the standardized scores of levels of development. The regional variations are summarized by classifying the blocks into very high (more than $\bar{X}$ + 1.5 SD), high ($\bar{X}$ + 0.5 to $\bar{X}$ + 1.5 SD), medium ($\bar{X}$ - 0.5 to $\bar{X}$ + 0.5 SD), low ($\bar{X}$ - 0.5 to $\bar{X}$ - 1.5 SD) and very low (less than $\bar{X}$ - 1.5 SD) grades.

Regional Patterns

The distributional pattern of aggregate productivity shows (Fig.23) that very high productivity is found in only one block of Nebua Naurangia in the northeastern part of the area. A compact and large region of high productivity lies in the eastern part covering about forty-two per cent blocks of the area. This region covers the entire district of Deoria and a large part of Gorakhpur district. This is a region which is obtained to a large extent as a region of very high and high productivity on all five indices separately. This region generally specializes in the production of sugarcane which is a major cash crop in the area under study. Besides high income from sugarcane, this is the region where the effect of Green Revolution is strongly felt. That is, apart from environmental edge of this region over other regions of the area, new technology of agricultural production associated with the Green Revolution has made here considerable headway resulting in the high productivity of other crops. However, it should be noted that high incidence of improved agricultural technology in this region has been result of initially high agricultural income.

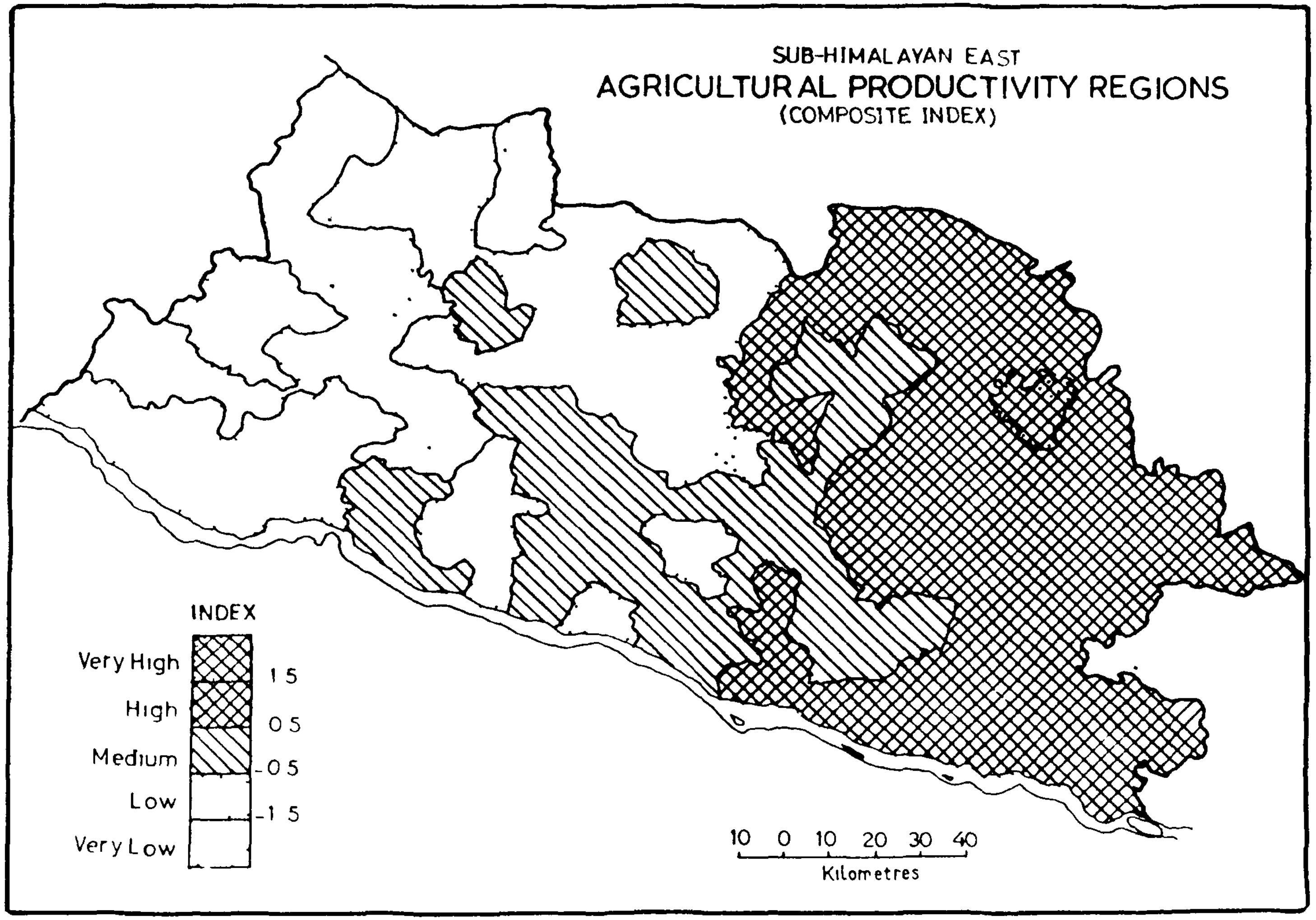
SUB-HIMALAYAN EAST
AGRICULTURAL PRODUCTIVITY REGIONS
(COMPOSITE INDEX)
INDEX
Very High
High
Medium
Low
Very Low
1 5
0 5
-0 5
-1 5
10 0 10 20 30 40
Kilometres

FIG 23

The blocks of medium productivity level are mainly concentrated in the central and southern part of the centre of the area. This level of productivity forms a large region and a few isolated pockets. It comprises twenty-two per cent of all the blocks of the area. The large region stretches east-west in the central part of the area. The small pockets of medium level of productivity are found in the northcentral part and in the southcentral part. Most of this region is found in southern Basti district and western Gorakhpur district. This region is characterized with the foodgrains production especially rice, wheat and pulses. In this region development of agricultural technology is of moderate order. Therefore, productivity is also moderate in this region.

Most of northern Basti and southern Gonda have extensive regions of low productivity level. This level of productivity is found in twenty-five per cent blocks of the area. This region is also characterized with the foodgrains production. However, yield of crops per hectare is low in comparison to the region of medium productivity level. It is mainly due to low fertility of soils in the region and lack of irrigation facilities. These drawbacks are added with the low level of technological development in the area.

In the north-west of the low productivity region are pockets of very low productivity grade. This region is extended over ten per cent of the blocks of the area and concentrated in the district of Gonda. This is an extension of low level of productivity region which is amplified due to poor technological and environmental conditions. It is to be noted that both the low and very low productivity regions have been areas of poverty and low agricultural incomes for a long time. These are also characterized with very small rather marginal landholdings.[4] The lack of surplus and small size of holdings have acted as constraint of technological development and monetized inputs. Almost entire farm-work is done by manual labour and by animals. A large part of area is generally devoted which are less demanding on water and soil fertility as maize, millets and barley. It is interesting to note that these crops besides their low yield per hectare also have low market value. As such, cropping pattern, initial low incomes and marginal landholdings are basic determinants of low productivity in this region.

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4 Munir, A. and Khan, M.F., Agricultural Typology in the Sub-Himalayan East, Paper presented at the 5th Annual Congress of the National Association of Geographers - India, Aligarh, December 1983.

COMPOSITE INDEX OF THE REGIONAL DEVELOPMENT

Computational Procedure

The composite index of the regional development is, in fact, a weighted aggregate of the five factors of development as obtained in chapter eight. The standardized factor scores of each factor are multiplied respectively by the respective percentage of total variance which they explain. As such, each dimension of development is weighted according to its contribution to the development levels in the area. In the case of the fifth factor which is a dimension of infrastructural underdevelopment, the factor scores are multiplied by negative per cent variance explained by this factor. Since positive values of the factor scores of this dimension mean underdevelopment and negative factor scores mean development of infrastructure, multiplication by negative value results in the weighted factor scores whereby positive values mean development of infrastructure and vice versa. These weighted factor scores of the five dimensions of development are added together to give a composite index of development. This aggregate index is standardized to zero mean and unit variance for interpretation (Appendix D). The positive values of this index mean high levels of development and negative values mean low levels of development. This index is classified into very high (more than 1.5 scores), high (0.5 to 1.5), medium (-0.5 to + 0.5), low (-0.5 to -1.5) and very low (less than - 1.5) levels of development (Fig.24).

Regional Patterns

The regional pattern of levels of development shows a compact region of very high and high level of development. The region of very high level of development includes eight per cent and the region of high level of development has nineteen per cent of all the blocks of the area. The region of very high and high level of development have a strong tendency to concentrate in the eastern part of the area. It is interesting to note that the overwhelming majority of the blocks of very high and high levels of development have strong association with the dimension of agricultural mechanization. These blocks are centred on one or other urban centre. Therefore, the majority of these blocks show very high and high factor scores on the dimension of urbanization and modernization. It may be noted further that these regions score equally high and very high on all other dimensions of development.

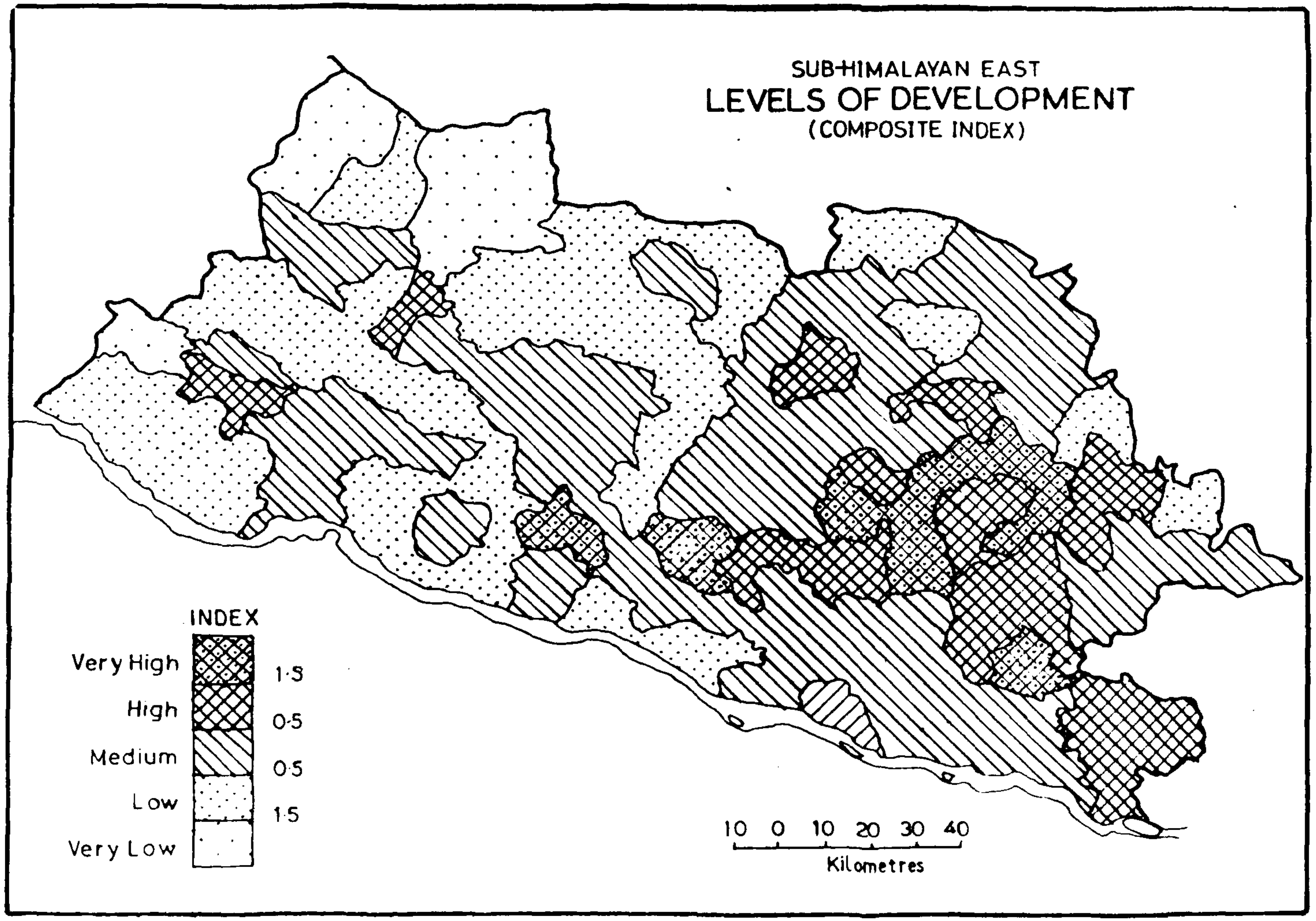

SUB-HIMALAYAN EAST
LEVELS OF DEVELOPMENT
(COMPOSITE INDEX)
INDEX
Very High
High
Medium
Low
Very Low
1·5
0·5
0·5
1·5
10 0 10 20 30 40
Kilometres

FIG. 24

The blocks having medium level of development are distributed throughout the area with a major concentration in the eastern half and southcentral part. This region covers about forty-four per cent blocks of the area. The blocks of this level of development exhibit scores ranging from low to high on dimensions of <u>agricultural mechanization and infrastructure, institutional development and agricultural intensity, industrialization and education, and urbanization and modernization</u>. However, the majority of these blocks score moderately on these dimensions. This level of development on cartographic comparison is found to be strongly related to the dimension of <u>agricultural mechanization and infrastructure</u>. That is, this level of development has medium scores on this dimension with few exceptions.

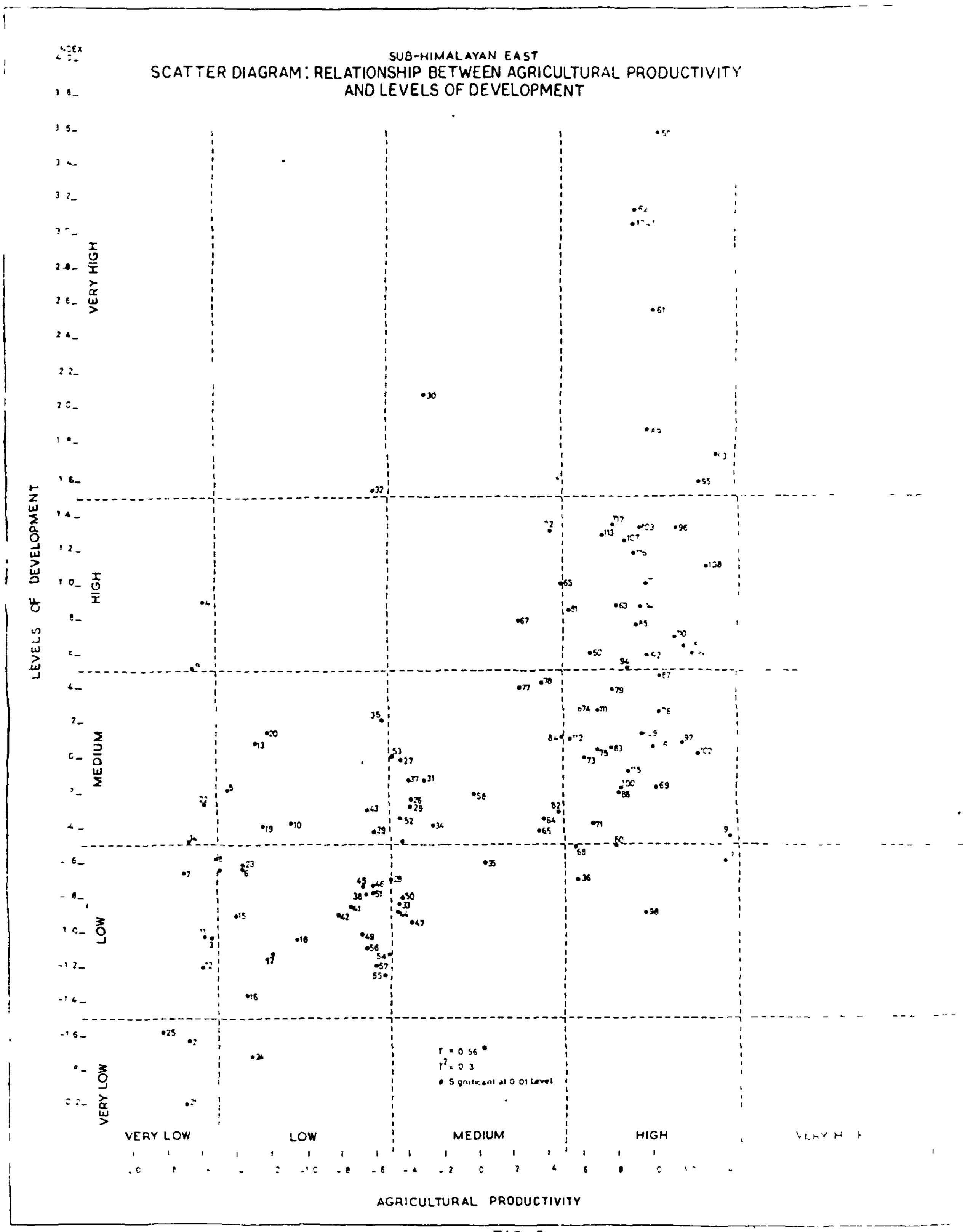
The level of low and very low development is mainly confined in the western half with a very few scattered pockets of low development in the eastern half of the area. A dominant region of low level of development is situated in the northcentral part of the area. The second large region of low level of development is located in central Gonda and south-west of Basti in the west of the area. A third ana relatively small region of the same grade lies in the southwestern part of the area.

In all, the low level of development is found in twenty-eight per cent of blocks. The very low level of development is confined in the northern Gonda in the west of the area. It is a very small region having only three per cent of all the blocks in the area. When compared with the dimensions of development in the area, it is found that low and very low level of development is highly associated with institutional development and agricultural intensity. That is, low level of this dimension of development contributes significantly to the low level of development of this region. The low development of this region is also due to low level of industrial and educational development on the one hand and agricultural mechanization and infrastructure on the other.

RELATIONSHIP BETWEEN AGRICULTURAL PRODUCTIVITY AND REGIONAL DEVELOPMENT

An examination of Fig.23 and Fig.24 reveals that agricultural productivity and levels of development generally decrease from east to west. This tendency is observed more strongly in the case of agricultural productivity than that of level of development. When the two maps are compared it is found that, excluding a few exceptions, all the blocks of very high and high levels of development are found in the regions of high and very high productivity. Similarly, medium level of development coincide with the medium and high level of productivity. A overwhelming majority of low and very low level of development are found in the blocks of low and very low agricultural productivity. This conformity of levels of development and agricultural productivity is observed more strongly in the eastern and central part of the area than in the western part of the area.

In order to analyse the relationship between agricultural productivity and levels of development a scatter diagram (Fig.25) is constructed. The X-axix of the diagram represents agricultural productivity and Y the levels of development. Vertical and horizontal lines demarcating the different levels of agricultural productivity and levels of development are drawn for the ease of analysis. An examination of the Figure reveals that out of eleven blocks having very low level of productivity, three blocks exhibit very low level of development, four low level of development, two medium level of development and two high level of development. While only one block of very low level of development lies in the low level of productivity. It means that at the lowest level of productivity there are considerable exceptions with respect


SUB-HIMALAYAN EAST
SCATTER DIAGRAM: RELATIONSHIP BETWEEN AGRICULTURAL PRODUCTIVITY AND LEVELS OF DEVELOPMENT
LEVELS OF DEVELOPMENT
VERY HIGH
HIGH
MEDIUM
LOW
VERY LOW
VERY LOW
LOW
MEDIUM
HIGH
AGRICULTURAL PRODUCTIVITY
r = 0.56
r^2 = 0.3
Significant at 0.01 Level

FIG·25

to level of development. Excluding the blocks of low level of development associated with the very low level of productivity, the blocks showing medium and high level of development in the range of very low productivity are those where one or another urban centre is found. It is interesting to note that larger the urban centre in the block higher is its level of development. It is due to their high score on urbanization and associated industrialization. There are thirty-one blocks in the low level of agricultural productivity. Of them a majority i.e. twenty-one blocks show low level of development, eight blocks medium level of development, one each block very high and very low levels of development. In this case the block of very high level of development is at considerable variance with respect to its level of agricultural productivity. Incidently this block is one of the highly urbanized blocks.

With regard to blocks showing medium level of development it is to be noted that majority of them is marginally medium nearer to the low level of development. Therefore, there is not considerable variation in the level of productivity and levels of development in this grade of productivity. In the medium grade of agricultural productivity there are twenty-five blocks, of which sixteen blocks have medium level of development, five low level of development, three high level of development and one very high level of development. As such, majority of the blocks show the same level of agricultural productivity and level of development. In the case of blocks showing a higher level of development it is to be pointed out that all of them have towns and cities which are cause of relatively a higher level of their development than expected on the basis of agricultural productivity. On the lower side of the development the blocks showing relatively lower levels of development in comparison to productivity are not considerably deviated from the lower limit of medium level of development. They have a tendency to concentrate towards medium level of development.

The high level of agricultural productivity has the maximum variance in the level of development. Out of forty-nine blocks in this productivity grade, eighteen exhibit a high level of development while twenty show medium level of development. Seven blocks have very high development level and four low level of development. In connection with the medium level of development in this grade of productivity it is to be noted that a majority of the blocks lie in the upper half of this level of development. Those blocks which show very high level of development invariably have large urban centres. The blocks in the lower half of the medium level of development and in the low level of development are overwhelmingly rural areas with moderate modernization and industrialization which does not commensurate with their level of agricultural productivity. There is an exceptional block of very high productivity which shows a medium level of development.

In general, there is observed a positive correlation between level of development and agricultural productivity on the scatter diagram. To ascertain this relationship product moment correlation is worked out. The coefficient of correlation (r) turns up as high as 0.56. This is significant at 99 per cent level of confidence. To find the amount of variance in the level of development explained by the agricultural productivity, coefficient of determination (r^2) is computed which is 0.31 i.e., about 31 per cent spatial variation in the levels of development is due to variation in agricultural productivity. This is a quite significant proportion of spatial variation which is explained by the agricultural productivity.

The findings of this analysis verify our hypothesis that the agricultural productivity is a component of regional development. That is, higher levels of development are associated with the higher levels of agricultural productivity and vice versa. In the area of study agricultural productivity appears to be a factor of urbanization, industrialization, infrastructural development and social development. In fact agriculture provides the resource base for urbanization and industrialization. Towns and cities have developed in the high productivity region to function as market centres for surplus agricultural production. In due course of time various functions as business, industrial and others have developed to cater the needs of rural as well as urban population. Industrialization in the area is generally agro-based. Raw materials from agriculture as sugarcane, foodgrains and oilseeds are processed in these insustries. Similarly to facilitate storage of surplus production godowns and stores have been developed and banks have sprung up in the region to facilitate business and commerce. In order to distribute surplus agricultural industrial production infrastructural facilities like railways and roads have been developed in the region. Similarly higher agricultural incomes due to high productivity have resulted in the social development through increased education. Higher income in rural areas have resulted in the development of schools and consequent in the development of literacy and education as higher income group people can afford education of their children in general.

On the contrary areas of low productivity suffer from the lack of urbanization, industrialization, infrastructural facilities and social development. The low productivity of the region results in subsistence type of farming in which no surplus is realized for marketing. Besides, agricultural land use in these areas is not conducive for the development of agro-based industries. Therefore, urbanization and industrialization is comparatively low in the region of low productivity. The lag in the urban and industrial development is the cause of lag in the development of the infrastructural facilities. The low incomes of the people of the region do not permit them to send their children to colleges, therefore, educational development and literacy is also low in the region.

As such, it is found that the agricultural productivity as a measure of efficiency of agricultural system through various links has a strong bearing on the level of development in the area under study.

CONCLUSIONS

The present study finds out that there exist large variations in the agricultural productivity at micro level in the Sub-Himalayan East. The general distributional pattern of agricultural productivity shows a marked decline from east to west. This pattern is in close conformity with the variation in the level of agricultural technology. The environmental factors as rainfall and soils are found less significant in causing these variations. In fact, variations in agricultural productivity reflect variation in the land use pattern and initial advantage of various regions in the area. It is found out that regions initially having relatively higher income are technologically more advanced and have a land use pattern which is more conducive for higher agricultural incomes. On the contrary, the regions which have been initially backward are lagging behind in the use of modern monetized inputs. Therefore, their land use pattern is less exacting on the modern inputs and dependent on the vagaries of monsoon and naturally available soil nutrients. The regions having higher productivity also have the initial advantage of agro-based industrialization. The demands of these industries and relatively higher prices offered by they have also contributed towards augmenting agricultural productivity.

Levels of regional development show many dimensions of progress and backwardness. There are found strong contrast in the levels of development between the regions of the area. A contignous region of high level of development is observed in the eastern part of the area which is relatively prosperous and well developed while a majority of the regions are moderately developed or underdeveloped. The general pattern of the levels of development also shows a east-west decline in the economic and social well-beings. However, in comparison to agricultural productivity there are considerable variations in the level of development and east-west declining regional pattern is not so strong as in the case of agricultural productivity. These variations are mainly caused by the dimensions of urbanization and modernization.

The relationship between agricultural productivity and level of development is verified cartographically and tested empirically. It is found that agricultural productivity is, to a great extent, a major compoent of levels of regional development. Statistically speaking relationship between agricultural productivity and levels of development is positive and high (0.56) i.e. the general development and agricultural progress go hand in hand.

Since agricultural productivity is a major component of regional development, progress in less developed regions in the study area depends largely on the improvement in agricultural productivity. However, agricultural productivity itself depends on the use of modern inputs as irrigation, fertilizers, high yielding varieties of seeds (HYVs) etc. In order to determine relationship between inputs and output the Cobb-Douglas production function is fitted as given below:

$$Y = 75\, X_1^{0.096} X_2^{0.015} X_3^{0.127} X_4^{0.047} X_5^{-0.159} \quad R^2 = 0.873$$

where

- Y is agricultural productivity in standard nutrition unit (SNU) per hectare,
- X_1 is per cent area under irrigation,
- X_2 is consumption of fertilizers per hectare,
- X_3 is per cent area under HYVs,
- X_4 is tractors per 10,000 hectares of cultivated land, and
- X_5 is agricultural workers per 1,000 hectares.

The relationship thus developed between productivity and various input factors revealed a significant result. All the coefficient are significant at more than 0.05 level of significance. It is found out that an increment of one per cent in irrigation, holding other inputs constant, brings a change of 0.096 per cent in agricultural productivity or it can bring an additional production of 5 SNUs per hectare in very low regions of the productivity. An increment of one per cent in fertilizer will bring a change of 0.015 per cent in the productivity or a gain of 1 SNU, if other variables are kept constant. Area under HYVs is also an important determinant of the productivity. A change of one per cent in HYVs is anticipated to bring a change of 0.127 per cent or an addition of 6 SNUs per hectare. Tractorization is another significant contributor to the productivity. In this case one per cent change in the tractorization will bring a change of 0.047 per cent in productivity or an addition of 2 SNUs. The case of labour use is typical as it has a negative sign of its exponent. It means that labour supply in agriculture is more than required. In this case one per cent decline in labour use will bring a change of 0.159 per cent in the productivity or an increased production of 8 SNUs.

The above discussion indicates that the variables by nature are most sensitive and where a slight change in the particular variable will bring an additional production of foodstuffs - and therefore, in case of one per cent positive change respectively in irrigation, fertilizers consumption, area under HYVs, tractors per 10,000 cultivated land one per cent negative change in agricultural workers respectively will bring an additional output of 5 + 1 + 6 + 2 + 8 = 22 SNUs or it can afford to sustain an additional population of about 22 persons per hectare in the very low productivity regions. Similarly by making a change of one per cent in inputs an additional population of 28 and 36 persons per hectare can be afforded in the regions of low and medium productivity respectively.[1]

Presently in the very low productivity region there are produced 19.35 million SNUs while the population is 1.41 million. It is estimated that population of this region by the turn of the century (i.e. 2001 A.D.) will be 2.14 million.[2] If one per cent increase in all inputs

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1 Additional output has been computed by multiplying mean productivity in a region by coefficient of different inputs.

2 Population is projected upto 2001 A.D. simply by applying growth rate of 1971-81 to the population of 1981 for two decades.

considered in the Cobb-Douglas production function is assumed these will be 8.55 million additional SNUs.[3] That is, in total there will be a surplus of 25.76 million SNUs to support an additional population of over 25 million. Similarly population of the low productivity region in 1981 has been 2.55 million. It is estimated to increase to 3.78 million by the turn of the century. At present there are 37.66 million SNUs produced in the region. It means that there are 33.88 million SNUs in surplus. Assuming one per cent change in all inputs there will be available 16.93 million SNUs in addition. By comparing with the population of 2001 A.D. there will be a total surplus of 50.81 million SNUs which can support an additional population of about 50 million. In the same manner, there will be a surplus of 83.66 million SNUs in the medium productivity region by 2001 A.D. which will feed additional population of about 83 million. The analysis reveals that only one per cent change in inputs in the very low productivity region will be sufficient to support the population by the turn of this century as it will be

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3 The existing SNUs are calculated by applying available SNUs per hectare to total cropped area in the blocks of a region and adding them together. One SNU is equivalent to 8,00,000 calories under Indian conditions sufficient to feed one person per annum.

20.75 million. The surplus SNUs obtained from the low and medium productivity regions will be exported to the other parts to feed about 134 million population.

In the final analysis it is observed that agriculture as a resource provides the base for industrialization and urbanization. The latter results in strengthening consequent industrial, commercial and business activities. To organize agricultural and industrial production and to facilitate commerce and trade, infrastructural facilities have also developed in the regions of high productivity.

It is strongly felt that low levels of agricultural productivity and resulting backwardness of the regions in the area is mainly due to lack of commercialization in the agricultural sector. It is reflected further. in the cropping pattern of these areas which is generally subsistence oriented. To develop these areas it is necessary to induce commercialization and monetization in the agricultural sector of these regions. To this effect commercial centres purchasing agricultural produce are to be opened /up there and agro-based industries are to be established in the interior of these regions. It is advisable in view of the experience of the eastern developed regions of the area, that local population of the backward regions should be encouraged and provided capital to establish small scale agro-based industries. This will help to gear the cropping pattern in the underdeveloped and medium developed regions towards commercial crops. The regions of kachhar and sandy loam soils can be utilized for groundnut cultivation at a large scale as these regions have favourable environment and greater potential for groundnut cultivation in the area of study. The introduction of commercial crops and associated industrialization will help monetization of agriculture in the area. The income obtained from cash crops is likely to be reinvested in the agriculture of these regions in the form of monetized inputs as fertilizers, pesticides, agricultural implements and tube-wells. This will result in increasing agricultural productivity in these regions.

Apart from efforts on commercialization and monetization of agriculture with associated industrialization, attempts should be made to modernize agriculture in the underdeveloped and medium developed regions of the area by giving loans on liberal interest and providing considerable subsidy in the purchase of inputs particularly to small and marginal landholders. The distribution of loans as well as financial assistance agencies are lacking in these regions, therefore, emphasis should be given to increase per capita loans and establish loan societies. Moreover, the procedure for obtaining loan which is presently complicated and time consuming should be made easy with social justice.

One of the problems to be faced in the incidence of modern inputs and resulting increase in agricultural productivity in the underdeveloped and medium developed regions is the rural unemployment. To cope this problem viable employment opportunities are to be created in these regions. In this context it may be noted that large scale rural to urban migration is taking place due to population growth and increasing pressure on land in rural areas. In the absence of viable employment opportunities due to sluggish growth of secondary and tertiary sectors most of the rural migrants concentrate in low paid petty services. They also cause pressure on urban facilities and amenities which are also developing very slowly. As a consequence these rural migrants live in very wretched conditions in urban areas. Therefore, this rural to urban migration stream is to be checked in the study area. This can be achieved to a great extent through rural industrialization which largely means that cottage and household industries are to be established in the rural areas. In case of the area under study the local population has the experience in cotton textile. Therefore, the unemployed population of the underdeveloped regions should also be encouraged to undertake cotton textile industry.

As a consequence of these steps there would be overall development of the region in which agricultural as well as the industrial sector of the regional economy will develop and prosper simultaneously. The incomes obtained from the development of agriculture and industrial sector would be used on education, health facilities and leisure resulting in social as well as cultural development. However, it should be noted that main stimulations to this process of general development will flow from the modernization of agriculture of the area.

The present study despite the paucity of data and other limitations has succeeded in demostrating regional variations at micro level in agricultural productivity and levels of development. It has succeeded in delineating areas of problems and progress with respect to agriculture and general development. It has also succeeded in confirming the hypothesis of interrelationship between agricultural productivity and regional development. However, it is felt that this hypothesis should be tested in the realities of other regions of the country so that uncovered links between agricultural productivity and development could be exposed.

APPENDIX A

INDICES OF AGRICULTURAL PRODUCTIVITY

S.No.	Name of the Block	Standard Nutrition Unit per hectare	Agri-cultural output per hectare in Rs.	Agri-cultural output per agri-cultural worker	Bhatia's Produc-tivity Index	Shafi's Produc-tivity Coeffi-cient Index
1	2	3	4	5	6	7
1.	Rupaidih	51.78	959	729.23	54.57	-43.53
2.	Katra Bazar	49.18	812	581.88	53.76	-42.49
3.	Haldhar Mau	52.35	967	554.61	55.51	-39.33
4.	Jhanjhari	52.91	1015	563.42	52.61	-42.73
5.	Pandari Kirpal	56.12	1004	723.88	53.42	-44.68
6.	Itiathok	49.11	1256	895.51	57.73	-52.97
7.	Mujehana	46.44	975	595.28	53.47	-49.18
8.	Shridattaganj	52.10	1039	645.21	55.44	-43.77
9.	Utraula	51.39	930	538.76	54.46	-44.53
10.	Gendas Buzurg	74.12	910	527.83	55.17	-12.56
11.	Rehra Bazar	52.55	986	554.30	55.09	-43.27
12.	Babhanjot	52.98	999	547.70	54.62	-43.89
13.	Mankapur	63.22	1065	694.40	55.33	-38.84
14.	Chhapia	47.11	992	546.25	54.85	-45.27
15.	Colonelganj	52.63	1129	801.03	58.53	-50.23
16.	Paraspur	57.44	1008	714.04	54.32	-34.66
17.	Belsar	57.42	1143	840.36	55.53	-34.59
18.	Tarabganj	62.56	1193	813.21	56.50	-27.43

contd......

APPENDIX A (Contd.......)

1	2	3	4	5	6	7
19.	Wazirganj	55.73	1270	761.09	56.62	-38.34
20.	Nawabganj	61.48	1145	750.35	54.66	-35.67
21.	Haraiya Satgharwa	49.46	774	625.44	53.57	-47.01
22.	Balrampur	49.69	911	672.60	53.07	-42.50
23.	Tulsipur	51.65	1085	860.54	51.43	-41.08
24.	Gainsari	54.79	996	882.85	52.37	-40.14
25.	Pachperwa	44.79	747	561.14	49.39	-45.31
26.	Bahadurpur	72.48	1395	993.01	94.82	-20.61
27.	Bankati	74.72	1428	833.30	93.43	-22.56
28.	Kudraha	75.62	1319	840.59	89.38	-23.60
29.	Saltauwa	65.59	1573	1071.40	93.13	-28.39
30.	Basti	86.67	1496	668.82	93.30	-13.10
31.	Saonghat	68.01	1658	977.88	94.39	-20.72
32.	Khalilabad	67.86	1427	757.35	96.15	-26.98
33.	Hainsar Bazar	77.07	1204	905.72	93.18	-23.95
34.	Baghauli	74.15	1533	815.95	98.90	-10.38
35.	Semariawan	71.84	1767	1303.45	97.08	-19.49
36.	Menhdawal	73.94	990	612.10	93.37	0.62
37.	Nathnagar	75.86	1290	933.17	94.72	-23.05
38.	Bansi	75.99	1056	660.16	88.87	-14.88
39.	Mithwal	68.14	1248	671.52	92.77	-10.62
40.	Rudhauli	69.27	1397	883.04	95.39	-19.12

contd......

APPENDIX A (Contd.........)

1	2	3	4	5	6	7
41.	Khesraha	68.47	1020	528.04	93.59	-8.11
42.	Santha	63.75	1212	690.33	83.72	-20.08
43.	Harraiya	68.95	1355	787.68	92.95	-30.24
44.	Parasrampur	79.27	1259	811.74	92.11	-22.16
45.	Gaur	64.83	1339	854.95	94.35	-32.85
46.	Captainganj	63.62	1359	921.45	92.30	-29.22
47.	Bikramjot	77.99	1239	890.51	95.59	-20.23
48.	Domariaganj	64.55	1270	647.72	93.89	-21.88
49.	Itwa	67.26	996	808.60	90.99	-16.52
50.	Bhanwapur	78.32	1133	770.82	94.73	-12.25
51.	Khuniaon	67.58	1186	744.33	93.75	-15.58
52.	Ramnagar	76.64	1326	802.48	95.32	-21.79
53.	Naugarh	79.09	1144	472.26	94.31	3.20
54.	Jogia	79.16	1037	747.78	90.96	-10.86
55.	Birdpur	71.38	940	722.92	92.70	- 0.87
56.	Barhni	72.16	1017	570.08	92.83	- 4.67
57.	Uska	71.69	1076	657.70	91.12	- 6.44
58.	Jangal Kauria	91.28	1402	981.00	115.80	-30.14
59.	Chargawan	101.64	2019	746.30	119.26	63.25
60.	Bhathat	89.53	2126	1015.35	125.38	5.80
61.	Pipraich	108.40	2191	1099.72	122.29	14.17
62.	Sardarnagar	109.88	2250	877.99	122.95	14.72

contd......

APPENDIX A (Contd.........)

1	2	3	4	5	6	7
63.	Khorabar	109.53	1614	1068.29	120.23	15.77
64.	Brahmpur	91.34	1540	998.49	115.33	7.44
65.	Sahjanwa	86.40	1872	1026.99	118.31	6.46
66.	Pali	92.63	1580	870.11	116.36	9.26
67.	Piprauli	84.97	1626	856.06	116.19	6.33
68.	Nautanwa	102.95	1430	906.22	129.49	10.13
69.	Lakshmipur	117.14	1738	1179.20	122.19	16.14
70.	Brijmanganj	120.38	1868	988.25	120.58	15.87
71.	Dhani	101.41	1751	984.26	120.80	11.65
72.	Pharenda	84.29	1782	1098.46	115.55	4.00
73.	Compierganj	90.78	1799	1113.26	122.08	8.11
74.	Barhalganj	85.85	1610	1390.44	114.25	7.13
75.	Gagaha	87.90	1690	1399.21	118.90	6.76
76.	Khazni	99.70	2286	1315.03	119.02	11.92
77.	Bansgaon	83.72	1777	1051.64	104.95	-0.77
78.	Kauri Ram	86.03	1537	1137.13	116.55	3.00
79.	Urwa	108.54	1761	1207.34	105.03	13.82
80.	Belghat	104.08	1524	1107.89	130.76	12.18
81.	Gola	105.09	1691	864.68	112.44	11.87
82.	Paniara	82.86	1824	1077.83	120.95	5.55
83.	Partawal	94.00	2275	1030.61	123.01	7.79
84.	Maharajganj	83.14	1930	1031.58	122.75	5.01
85.	Ghughuli	102.50	2215	1047.53	123.55	12.40

contd........

APPENDIX A (Contd.........)

1	2	3	4	5	6	7
86.	Mithaura	88.99	1801	998.22	122.25	13.84
87.	Siswa	94.64	2157	1247.65	122.50	26.81
88.	Nichlaul	89.68	2096	1407.55	109.22	10.14
89.	Captainganj	93.89	2557	1155.70	126.94	7.02
90.	Khadda	92.75	2490	1953.57	121.72	6.42
91.	Nebua Naurangia	121.04	3259	1728.83	122.43	98.38
92.	Motichak	90.87	2669	1218.27	121.61	5.46
93.	Ramkola	90.96	3198	1512.96	124.42	3.23
94.	Sukrauli	81.75	2610	1203.83	128.51	2.22
95.	Hata	91.29	2985	1425.56	127.64	2.81
96.	Kasia	96.30	2518	1287.84	127.77	9.92
97.	Tamkuhi	97.25	2480	1359.66	125.68	11.78
98.	Dudhai	99.74	2281	1098.10	126.00	11.49
99.	Padrauna	91.13	2855	1503.94	117.27	8.47
100.	Fazilnagar	95.62	2202	1055.17	129.58	6.76
101.	Bishunpura	90.05	2804	1856.38	119.44	3.78
102.	Siwarhi	89.99	2737	1513.07	124.46	9.98
103.	Gauri Bazar	92.52	2293	1257.35	125.34	7.53
104.	Deoria	95.01	2275	1189.88	127.65	4.96
105.	Desai Deoria	99.70	2394	1360.82	128.94	8.82

contd...........

APPENDIX A (Contd..........)

1	2	3	4	5	6	7
106.	Pathardewa	99.51	2243	1218.25	130.52	6.94
107.	Baitalpur	92.47	2540	1034.93	126.99	3.43
108.	Rampur Karkhana	97.72	2733	1428.02	130.18	6.10
109.	Rudrapur	99.49	1860	1061.04	127.20	30.44
110.	Bankata	86.74	2615	1530.28	126.76	2.53
111.	Barhaj	91.41	1568	1293.55	127.60	7.22
112.	Bhagalpur	85.39	1748	1095.56	127.22	4.12
113.	Bhatni	90.98	1992	1158.85	127.70	3.25
114.	Bhatpar	89.65	2462	1219.85	127.92	5.86
115.	Bhaluani	96.59	1830	1286.53	129.95	7.57
116.	Lar	85.64	1973	1491.41	128.97	5.03
117.	Salempur	95.76	2049	1082.02	128.56	5.71

APPENDIX B

VARIABLES OF REGIONAL DEVELOPMENT

set/Variable	Description
ultural Development	
ultiple cropping	Area sown more than once as the per cent of net sown area.
rrigation	Gross irrigated area as the per cent of total cropped area.
ertilizers	Use of NPK kg/hectare.
igh yielding varieties (HYVs)	Area under HYVs as per cent of total cropped area.
ractorization	Number of tractors per 10,000 hectares of cultivated area
ube-wells and pump sets	Number of tube-wells and pump sets per 10,000 hectares of cultivated area
ization and Industrialization	
rban population	Urban population as per cent of total population
rban-rural ratio	Ratio of urban population to rural population
actories	Number of registered factories per 100,000 of population
actory workers	Registered factory workers as per cent of total workers
econdary workers	Secondary workers as per cent of total workers
ertiary workers	Tertiary workers as per cent of total workers
structure and Amenities	
oad length	Road length in km per 100,000 of population
oad density	Road density per 100 sq. km
anks	Number of banks per 100,000 of population
lectrification	Number of electrified villages as per cent of total villages
obar gas plant	Number of gobar gas plants per 100,000 of population
eed and fertilizer storages	Number of seed and fertilizer storages per 10,000 of cultivated area
l Development	
iteracy	Literate persons as per cent of total population
chools	Number of schools per 100,000 of population

APPENDIX C

STANDARDIZED FACTOR SCORES OF REGIONAL DEVELOPMENT

S.No.	Name of the Block	Factor I	Factor II	Factor III	Factor IV	Factor V
1	2	3	4	5	6	7
1.	Rupaidih	-0.574	-0.860	-0.464	-0.322	0.642
2.	Katra Bazar	-2.032	-1.699	-1.232	-0.944	1.182
3.	Haldhar Mau	-1.274	-0.940	-0.968	-0.644	0.653
4.	Jhanjhari	-0.124	0.288	0.877	2.537	-0.653
5.	Pandari Kirpal	0.225	-0.260	-0.686	-0.274	-0.110
6.	Itiathok	-0.353	-0.781	-0.619	-0.454	0.666
7.	Mujehana	-0.472	-0.584	-0.659	-0.547	0.725
8.	Shridattaganj	-0.515	-0.453	-0.319	-0.478	0.858
9.	Utraula	-0.114	0.670	0.147	0.915	-0.801
10.	Gendas Buzurg	-0.501	-0.271	-0.524	-0.005	-0.385
11.	Rehra Bazar	-0.638	-1.115	-1.000	-0.822	1.048
12.	Babhanjot	-0.941	-1.034	-1.131	-0.983	1.301
13.	Mankapur	-0.062	-0.069	-0.292	0.274	-0.620
14.	Chhapia	-0.320	-0.620	-0.208	-0.291	0.749
15.	Colonelganj	-1.793	-0.762	-0.863	0.101	0.460
16.	Paraspur	-1.507	-1.256	-1.127	-0.777	1.349
17.	Belsar	-1.198	-1.053	-1.103	-0.622	0.988
18.	Tarabganj	-1.066	-0.800	-1.003	-0.634	1.121

contd........

APPENDIX C (Contd........)

1	2	3	4	5	6	7
19.	Wazirganj	-0.182	-0.399	-0.583	-0.185	0.494
20.	Nawabganj	-0.831	0.087	-0.362	0.523	-0.752
21.	Haraiya Satgh-arwa	-2.619	-1.872	-1.353	-1.365	1.520
22.	Balrampur	-1.117	-1.069	0.348	1.014	0.124
23.	Tulsipur	-1.840	-0.545	-0.159	-0.119	-0.306
24.	Gainsari	-2.275	-1.642	-1.107	-1.181	1.280
25.	Pachperwa	-2.348	-1.537	-0.843	-0.693	1.425
26.	Bahadurpur	0.068	-0.586	-0.381	-0.308	-0.143
27.	Bankati	0.383	-0.419	0.386	-0.235	-0.313
28.	Kudraha	-0.275	-0.623	-0.562	-0.599	1.217
29.	Saltauwa	0.234	-0.417	-0.200	-0.355	0.627
30.	Basti	1.449	1.176	2.431	2.823	-1.449
31.	Saonghat	0.584	-0.432	-0.201	-0.210	0.490
32.	Khalilabad	0.895	0.611	2.463	2.172	-0.829
33.	Hainsar Bazar	-0.732	-1.113	-0.313	-0.595	1.018
34.	Baghauli	0.104	-0.757	-0.118	-0.292	0.820
35.	Semariawan	-0.226	-0.825	-0.326	-0.482	0.904
36.	Menhdawal	-0.360	-0.429	1.168	1.038	0.413
37.	Nathnagar	0.006	-0.488	0.377	0.051	0.586
38.	Bansi	-1.126	-0.662	-0.907	-0.152	0.502
39.	Mithwal	0.219	-0.728	-0.265	-0.514	0.760
40.	Rudhauli	0.047	-0.674	-0.598	-0.534	0.446

contd.....

APPENDIX C (Contd.........)

1	2	3	4	5	6	7
41.	Khesraha	-0.925	-1.010	-0.518	-0.673	0.578
42.	Santha	-0.667	-1.115	-0.543	-0.685	1.055
43.	Harraiya	0.123	-0.019	-0.703	-0.400	0.445
44.	Parasrampur	-0.496	-0.775	-0.944	-0.937	0.849
45.	Gaur	-0.165	-0.732	-0.864	-0.678	0.992
46.	Captainganj	-0.052	-1.285	-0.660	-0.460	0.926
47.	Bikramjot	-0.866	-0.903	-0.914	-0.760	0.705
48.	Domariaganj	-0.152	-0.353	-0.731	-0.498	0.571
49.	Itwa	-1.030	-0.896	-0.722	-0.971	0.848
50.	Bhanwapur	-0.554	-0.859	-0.636	-0.708	0.869
51.	Khuniaon	-0.459	-1.053	-0.530	-0.645	0.790
52.	Ramnagar	0.141	-0.845	-0.110	-0.374	0.435
53.	Naugarh	-0.601	0.262	-0.191	0.371	-0.326
54.	Jogia	-1.349	-0.889	-0.824	-0.985	0.925
55.	Birdpur	-1.547	-1.369	-0.850	-0.772	0.892
56.	Barhni	-1.294	-1.178	-0.809	-0.696	0.782
57.	Uska	-1.362	-1.091	-0.912	-0.942	0.942
58.	Jangal Kauria	-0.059	-0.466	0.338	0.011	0.876
59.	Chargawan	1.933	2.180	3.753	6.554	-1.808
60.	Bhathat	1.413	1.036	0.077	0.022	0.176
61.	Pipraich	2.301	2.868	2.475	1.706	-1.976

Contd.......

APPENDIX C (Contd........)

1	2	3	4	5	6	7
62.	Sardarnagar	2.359	3.410	3.306	2.166	-2.785
63.	Khorabar	0.652	1.226	0.717	0.620	-0.685
64.	Brahmpur	0.103	0.057	-0.418	-0.572	0.901
65.	Sahjanwa	0.712	1.184	1.699	0.702	-0.041
66.	Pali	-0.278	-0.023	-0.547	-0.353	0.760
67.	Piprauli	0.482	0.951	0.303	0.844	-1.027
68.	Nautanwa	-1.064	-0.118	-0.432	-0.170	0.361
69.	Lakshmipur	0.227	0.493	-0.637	-0.611	0.409
70.	Brijmanganj	0.198	0.643	-0.301	-0.170	-0.023
71.	Dhani	-0.532	0.144	-0.460	-0.377	0.471
72.	Pharenda	0.939	1.728	1.627	0.697	-0.723
73.	Compierganj	-0.017	0.600	-0.504	-0.070	0.128
74.	Barhalganj	-0.181	0.901	0.176	0.598	0.267
75.	Gagaha	0.435	0.436	0.032	-0.102	0.854
76.	Khazni	0.644	0.496	-0.040	0.043	0.134
77.	Bansgaon	0.758	0.618	0.134	0.327	0.241
78.	Kauri Ram	0.423	0.881	0.198	0.321	-0.003
79.	Urwa	0.501	1.047	-0.192	0.161	-0.140
80.	Belghat	-0.126	-0.310	-0.449	-0.419	1.071
81.	Gola	1.162	1.066	0.081	0.630	-0.738
82.	Paniara	0.108	0.216	-0.580	-0.737	0.546
83.	Partawal	0.588	0.464	-0.514	-0.427	0.035

contd.......

APPENDIX C (Contd........)

1	2	3	4	5	6	7
84.	Maharajganj	0.498	0.636	-0.413	-0.468	-0.131
85.	Ghughuli	0.811	0.983	0.799	-0.061	-0.805
86.	Mithaura	-0.341	-0.245	-0.945	-0.906	0.788
87.	Siswa	0.413	0.700	0.678	0.172	-0.088
88.	Nichlaul	-0.623	0.416	-0.146	-0.349	0.175
89.	Captainganj	2.149	1.600	1.662	0.585	-2.366
90.	Khadda	-0.927	-0.492	0.308	-0.721	0.053
91.	Nebua Naurangia	-0.064	-0.234	-0.463	-0.803	-0.200
92.	Motichak	0.707	-0.191	-0.633	-0.665	-0.256
93.	Ramkola	0.989	1.180	2.969	0.711	-2.079
94.	Sukrauli	1.046	0.355	-0.391	-0.165	-0.398
95.	Hata	1.578	1.926	0.682	0.468	-2.438
96.	Kasia	1.217	1.291	0.567	0.485	-2.470
97.	Tamkuhi	0.171	-0.264	-0.292	-0.386	-1.296
98.	Dudhai	-0.797	-0.878	-0.832	-0.996	0.426
99.	Padrauna	0.313	-0.070	1.071	0.657	-0.853
100.	Fazilnagar	0.467	-0.311	-0.755	-0.705	-0.539
101.	Bishunpura	-0.811	-0.338	-0.617	-0.731	-0.029
102.	Siwarhi	-0.701	-0.494	1.168	0.192	-0.108

contd.......

APPENDIX C (Contd.........)

1	2	3	4	5	6	7
103.	Gauri Bazar	1.648	1.070	1.016	0.470	-1.656
104.	Deoria	2.314	3.102	2.239	2.700	-3.477
105.	Desai Deoria	1.353	0.707	-0.230	-0.221	-1.139
106.	Pathardewa	0.712	0.032	-0.562	-0.609	-0.646
107.	Baitalpur	1.807	1.031	1.159	0.114	-1.375
108.	Rampur Karkhana	1.641	1.404	0.316	0.138	-1.271
109.	Rudrapur	-0.041	0.304	0.115	0.186	-0.001
110.	Bankata	0.432	0.507	1.324	0.143	-0.711
111.	Barhaj	0.213	-0.278	0.094	0.867	-0.360
112.	Bhagalpur	0.354	-0.340	-0.202	0.061	-0.620
113.	Bhatni	0.791	0.692	2.521	0.945	-0.781
114.	Bhatpar	0.994	1.003	0.388	0.489	-0.968
115.	Bhaluani	0.410	-0.160	-0.473	-0.236	0.002
116.	Lar	0.906	1.265	0.555	1.067	-1.546
117.	Salempur	1.146	1.394	0.490	1.213	-1.797

APPENDIX D

COMPOSITE INDEX

S.No.	Name of the Block	Composite Index of Agricultural Productivity	Composite Index of Regional Development
1	2	3	4
1.	Rupaidih	-1.480	-0.644
2.	Katra Bazar	-1.665	-1.626
3.	Haldhar Mau	-1.544	-1.028
4.	Jhanjhari	-1.568	0.896
5.	Pandari Kirpal	-1.435	-0.192
6.	Itiathok	-1.351	-0.635
7.	Mujehana	-1.694	-0.660
8.	Shridattaganj	-1.500	-0.576
9.	Utraula	-1.635	0.508
10.	Gendas Buzurg	-1.071	-0.384
11.	Rehra Bazar	-1.574	-1.024
12.	Babhanjot	-1.577	-1.195
13.	Mankapur	-1.274	0.080
14.	Chhapia	-1.665	-0.479
15.	Colonelganj	-1.387	-0.902
16.	Paraspur	-1.325	-1.359
17.	Belsar	-1.178	-1.123
18.	Tarabganj	-1.039	-1.036

contd......

APPENDIX D (Contd........)

1	2	3	4
19.	Wazirganj	-1.230	-0.403
20.	Nawabganj	-1.204	0.139
21.	Haraiya Satgharwa	-1.688	-2.001
22.	Balrampur	-1.566	-0.271
23.	Tulsipur	-1.352	-0.610
24.	Gainsari	-1.312	-1.718
25.	Pachperwa	-1.820	-1.577
26.	Bahadurpur	-0.374	-0.242
27.	Bankati	-0.432	-0.023
28.	Kudraha	-0.500	-0.701
29.	Saltauwa	-0.385	-0.276
30.	Basti	-0.284	2.070
31.	Saonghat	-0.306	-0.131
32.	Khalilabad	-0.586	1.543
33.	Hainsar Bazar	-0.450	-0.841
34.	Baghauli	-0.254	-0.394
35.	Semariawan	0.037	-0.599
36.	Menhdawal	-0.543	0.207
37.	Nathnagar	-0.393	-0.130
38.	Bansi	-0.641	-0.777

contd.......

APPENDIX D (Contd........)

1	2	3	4
39.	Mithwal	-0.586	-0.426
40.	Rudhauli	-0.428	-0.477
41.	Khesraha	-0.734	-0.846
42.	Santha	-0.805	-0.902
43.	Harraiya	-0.636	-0.298
44.	Parasrampur	-0.460	-0.881
45.	Gaur	-0.659	-0.739
46.	Captainganj	-0.605	-0.735
47.	Bikramjot	-0.382	-0.936
48.	Domariaganj	-0.733	-0.499
49.	Itwa	-0.665	-1.007
50.	Bhanwapur	-0.433	-0.803
51.	Khuniaon	-0.604	-0.771
52.	Ramnagar	-0.444	-0.348
53.	Naugarh	-0.485	0.004
54.	Jogia	-0.493	-1.129
55.	Birdpur	-0.537	-1.246
56.	Barhni	-0.636	-1.089
57.	Uska	-0.591	-1.182
58.	Jangal Kauria	-0.014	-0.214
59.	Chargawan	1.065	3.590
60.	Bhathat	0.665	0.599

contd......

APPENDIX D (Contd.........)

1	2	3	4
61.	Pipraich	1.031	2.559
62.	Sardarnagar	0.930	3.137
63.	Khorabar	0.806	0.878
64.	Brahmpur	0.387	-0.346
65.	Sahjanwa	0.486	0.996
66.	Pali	0.358	-0.419
67.	Piprauli	0.242	0.791
68.	Nautanwa	0.572	-0.506
69.	Lakshmipur	1.041	-0.175
70.	Brijmanganj	0.985	0.104
71.	Dhani	0.666	-0.377
72.	Pharenda	0.429	1.295
73.	Compierganj	0.619	-0.015
74.	Barhalganj	0.599	0.280
75.	Gagaha	0.697	0.038
76.	Khazm	1.056	0.259
77.	Bansgaon	0.254	0.397
78.	Kauri Ram	0.385	0.430
79.	Urwa	0.796	0.394
80.	Belghat	0.789	-0.498
81.	Gola	0.540	-0.845
82.	Paniara	0.472	-0.311

contd......

APPENDIX D (Contd......)

1	2	3	4
83.	Partawal	0.784	0.055
84.	Maharajganj	0.493	0.112
85.	Ghughuli	0.925	0.758
86.	Mithaura	0.573	-0.699
87.	Siswa	1.065	0.475
88.	Nichlaul	0.825	-0.205
89.	Captainganj	0.998	1.877
90.	Khadda	1.451	-0.453
91.	Nebua Naurangia	2.781	-0.308
92.	Motichak	0.986	0.594
93.	Ramkola	1.387	1.738
94.	Sukrauli	0.869	0.510
95.	Hata	1.276	1.576
96.	Kasia	1.137	1.318
97.	Tamkuhi	1.183	0.082
98.	Dudhai	0.962	-0.891
99.	Padrauna	1.243	0.605
100.	Fazilnagar	0.841	-0.167
101.	Bishunpura	1.425	-0.588
102.	Siwarhi	1.267	0.021

contd......

APPENDIX D (Contd..........)

1	2	3	4
103.	Gauri Bazar	0.943	1.320
104.	Deoria	0.918	3.063
105.	Desai Deoria	1.186	0.636
106.	Pathardewa	1.023	0.061
107.	Baitalpur	0.860	1.254
108.	Rampur Karkhana	1.315	1.096
109.	Rudrapur	0.961	0.126
110.	Bankata	1.143	0.690
111.	Barhaj	0.702	0.265
112.	Bhagalpur	0.528	0.099
113.	Bhatni	0.727	1.276
114.	Bhatpar	0.952	0.868
115.	Bhaluani	0.882	-0.087
116.	Lar	0.906	1.177
117.	Salempur	0.786	1.334

APPENDIX E

CORRELATION MATRIX OF TWENTY VARIABLES OF REGIONAL DEVELOPMENT

	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0																
3	1.000															
6	0.259	1.000														
5	0.042	0.240	1.000													
5	0.048	0.255	0.920	1.000												
6	0.244	0.274	0.545	0.445	1.000											
3	0.329	0.096	0.287	0.199	0.665	1.000										
2	0.264	0.318	0.422	0.427	0.536	0.628	1.000									
4	0.247	0.177	0.185	0.089	0.266	0.259	0.270	1.000								
1	0.277	0.113	0.297	0.164	0.369	0.305	0.171	0.292	1.000							
3	0.485	0.308	0.365	0.295	0.412	0.352	0.356	0.359	0.853	1.000						
6	0.222	0.281	0.261	0.175	0.253	0.248	0.254	0.374	0.355	0.470	1.000					
8	0.433	0.401	0.279	0.256	0.376	0.313	0.277	0.175	0.251	0.401	0.154	1.000				
0	0.330	0.430	0.227	0.207	0.324	0.253	0.324	0.384	0.216	0.398	0.725	0.287	1.000			
1	0.662	0.116	0.189	0.121	0.257	0.315	0.163	0.327	0.492	0.614	0.372	0.338	0.304	1.000		
2	0.273	0.458	0.648	0.656	0.419	0.235	0.470	0.332	0.263	0.494	0.365	0.293	0.405	0.294	1.000	

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